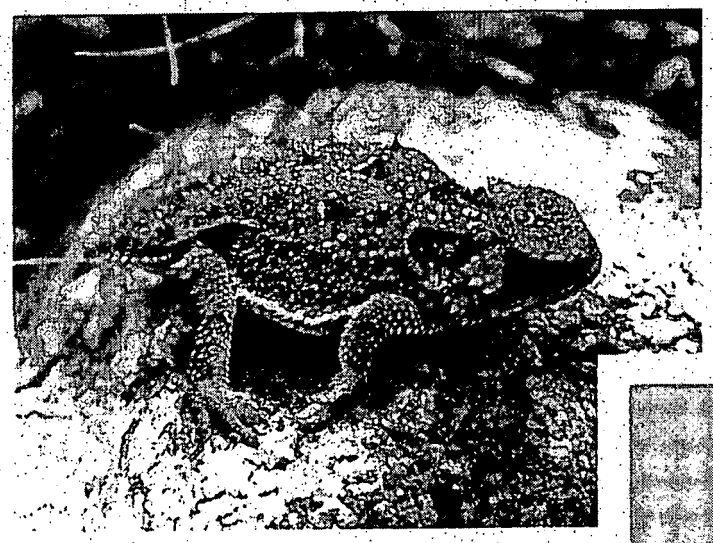
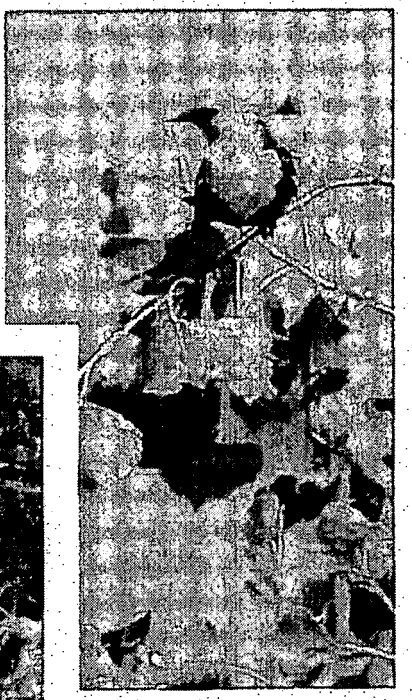
1998 annual Wildlife Survey Report

ECOLOGY

1998 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site





1998 Annual Wildlife Survey Report for the Rocky Flats Environmental Technology Site

June 1, 1999

Prepared for
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by
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Acronyms and Abbreviations

BEPA	Bald Eagle Protection Act
BZ	Buffer Zone
CDOW	Colorado Division of Wildlife
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CNHP	Colorado Natural Heritage Program
CWA	Clean Water Act
DOE	U.S. Department of Energy
ESA	Endangered Species Act
FNWA	Federal Noxious Weed Act
FWCA	Fish and Wildlife Coordination Act
IMP	Integrated Monitoring Plan
MBTA	Migratory Bird Treaty Act
NRCPP	Natural Resource Compliance and Protection Program
NRD	Natural Resource Damage
NTCA	Colorado Nongame, Threatened and Endangered Species Conservation Act
PIT	Passive Integrated Transponder
RFFO	Rocky Flats Field Office
Site	Rocky Flats Environmental Technology Site
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator

Executive Summary

This report summarizes the results of 1998 wildlife surveys performed at Rocky Flats Environmental Technology Site (Site). These surveys were performed as part of a long-term natural resource management program, the Natural Resource Compliance and Protection Program (NRCPP), at the Site. This was the program's second year under the Integrated Monitoring Plan (IMP) (K-H 1997d). Wildlife monitoring under the IMP uses previously established baseline data as the standard against which subsequent results are measured. Therefore, results from 1998 wildlife monitoring were compared to previous years to assess wildlife trends at the Site.

Assessment of wildlife population trends at the Site provides the Department of Energy, Rocky Flats Field Office (DOE, RFFO) and the Site contractors with a basis for making management and compliance decisions regarding wildlife and wildlife habitat at the Site. The NRCPP monitoring under the IMP also supports DOE in its role as Natural Resource Trustee and provides data that are essential to DOE's goal of preserving the unique ecological values of the Site, in keeping with the Rocky Flats Vision, as stated in the Rocky Flats Cleanup Agreement (DOE et al. 1996), and with the Natural Resource Management Policy developed by DOE (1998).

Because wildlife populations are dynamic, and vary with natural pressures and human influences, long-term monitoring is an essential assessment tool for delineating the effects of different influences. Ecological monitoring will become increasingly important as remediation activities at the Site progress. This monitoring will also establish trends or changes as they relate to natural resource damage during Site operations, and will aid DOE in responding to potential Natural Resource Damage (NRD) litigation.

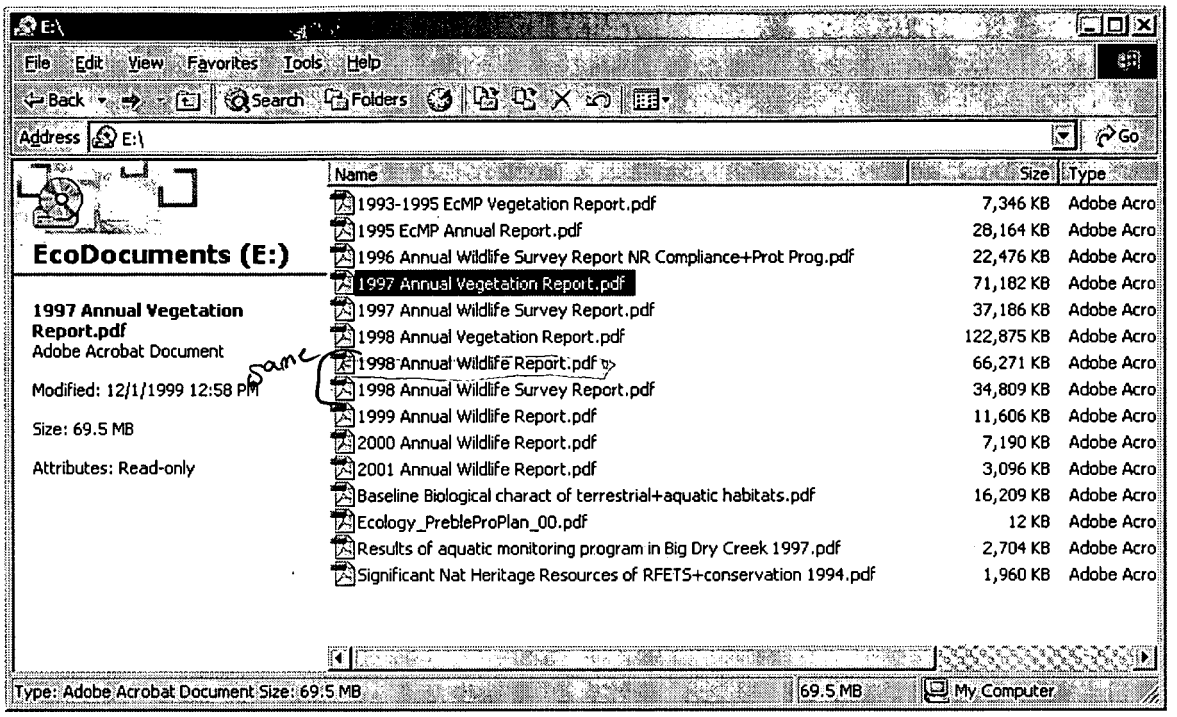
The 1998 sampling results indicate that the Site continues to provide a unique refuge for a diverse wildlife community along the increasingly disturbed and fragmented habitat of Colorado's central Front Range. The large, undisturbed tract of natural habitats at the Site provides a variety of ecological niches for common and uncommon species alike. The continued presence of these species is a significant indicator that the ecological health of the Site has not been adversely affected by Site activities.

At the end of the 1998 field season, 251 terrestrial vertebrate species had been verified as using the Site's ecosystems. This is an impressive diversity when compared to the 322 terrestrial vertebrate species found at Rocky Mountain National Park, an area 98 percent larger than the Site. The Site's diversity includes 191 species of birds, 19 of which are raptors; 3 big game species; 11 species of carnivores; 3 lagomorphs (rabbits and hares); 6 large rodents; 22 small mammal species, including the Preble's meadow jumping mouse; 9 reptiles; and 7 amphibians recorded since 1991. This high species diversity and continued use of the Site by numerous special-concern species verifies that habitat quality

for these species has remained acceptable and that ecosystem functions are being maintained.

Section 1

Introduction



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1. Introduction

1.1 Background

Rocky Flats Environmental Technology Site (the Site) is a U.S. Department of Energy (DOE) nuclear industrial facility that has been part of the nationwide nuclear weapons complex since 1951. The Site is located in rural Jefferson County, Colorado, approximately 16 miles northwest of Denver, and 5 miles southeast of Boulder. The Site covers approximately 6,262 acres, of which approximately 5,900 acres forms an undeveloped Buffer Zone (BZ) around the central industrialized portion. The original 1951 land purchase included approximately 2,520 acres of rangeland, which was expanded by an additional 4,030 acres from private ranches in 1974 (some 290 acres were later allocated to the National Renewable Energy Laboratory). The Site adjoins undeveloped rangelands that are encroached by housing developments on the northeast and southeast. To the north, east, west, and northwest, public open-space lands border the Site. Figure 1-1 presents the general location of the Site.

The original mission of this DOE facility was the manufacture of nuclear weapons components. With the end of the Cold War and cessation of nuclear weapons production at the facility, the Site is currently undergoing cleanup and closure. During the next eight years, buildings will continue to be demolished, and disturbed areas will be planted back to native prairie. One of the current DOE goals is to preserve the Site's unique ecological resources. Certain natural resource protection goals are identified in the Natural Resource Management Policy issued by DOE in 1998 (DOE 1998). Ecological monitoring is necessary to ensure regulatory compliance, to attain DOE's natural resource protection goals, and to preserve and protect these unique ecological resources to the maximum extent possible during cleanup and closure. The Natural Resource Compliance and Protection Program (NRCPP) provides for such ecological monitoring.

1.2 The Natural Resource Compliance and Protection Program

The NRCPP monitors the status of plant communities, wildlife, and habitats to ensure that operations at the Site remain in compliance with state and federal wildlife protection statutes and regulations, and with DOE orders. Other goals of the program are to collect sufficient data to provide a scientific basis for National Environmental Policy Act (NEPA) documentation and to support cleanup and closure of the Site.

The regulatory drivers for NRCPP wildlife and habitat work include:

- The Endangered Species Act (ESA) (USC 1973b)
- The Fish and Wildlife Coordination Act (FWCA) (USC 1958)

- The Migratory Bird Treaty Act (MBTA) (USC 1973a)
- The Bald and Golden Eagle Protection Act (BEPA) (USC 1978)
- The National Environmental Policy Act (USC 1970)
- The Clean Water Act (CWA) (USC 1977)
- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (USC 1980)
- The Federal Noxious Weed Act (FNWA) (USC 1975)
- CFR Part 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements (CFR 1979)
- CFR Part 230, 404(b)(1), Guidelines for Specification of Disposal Sites for Dredged or Fill Material (CFR 1980)
- The Colorado Nongame, Threatened and Endangered Species Conservation Act (NTECA) (CO 1991)
- Executive Order 11990, Protection of Wetlands (EO 1977a)
- Executive Order 11988, Floodplain Management (EO 1977b)
- DOE Order 4300.1B, Real Property Management (DOE 1989a)
- DOE Order 6430.1A, General Requirements, Construction Facilities and Temporary Controls (DOE 1989b)
- DOE Order 5400.1, General Environmental Protection Program (DOE 1988).

Since the Natural Resource Compliance and Protection Program (NRCPP) was established in 1992, Site ecologists have conducted routine surveys to monitor the health and populations of high-visibility and sensitive wildlife groups such as migratory birds, game species, indicator organisms (e.g., raptors and amphibians are groups that are more sensitive to contaminants and stress), and species that are afforded special protection by federal and state statutes. The methods used are set forth in the Site's standard operating procedures, *EMD Operating Procedures Manual Volume V* (DOE 1994a). Continuation of this program as a long-term monitoring program has provided a continuous record of these selected species that can be compared among years. These long-term surveys were the basis of Chapter 5, Ecological Monitoring, of the *Rocky Flats Environmental Technology Site Integrated Monitoring Plan* (IMP) (K-H 1998a). Each year the IMP is reviewed, and special sampling and monitoring may be added to address specific questions or additional data needs. This ongoing monitoring program is an important environmental management tool for DOE, Rocky Flats Field Office (RFFO) and its contractors. Data from these surveys, which are archived in the Site ecological database, have been used in the preparation of compliance documents, environmental evaluations,

remediation plans, environmental assessments, environmental impact statements, categorical exclusions, and project planning documents. These data are also used to make ecological resource management decisions to ensure the preservation of these resources at the Site.

Routine monitoring provides data on habitat affinities of sensitive species, which can then be used to predict the presence or absence of such species within planned work areas, avoiding the expense of additional special surveys. Availability of such information allows timely assessment of proposed actions for potential ecosystem impacts, thus reducing project delays. These data are therefore a valuable planning tool that can help avoid conflicts between project scheduling and protective regulations. Monitoring also provides data for management decisions under the *Ecological Resource Management Plan* (K-H 1997a). Continued monitoring of wildlife populations at the Site will also provide valuable background data for addressing CERCLA-related Natural Resource Damage Assessment (NRDA) concerns in the future.

The NRCPP ecological monitoring program also supports documentation and protection of threatened and endangered species to comply with the ESA and NTECA, and addresses migratory bird protection concerns under the MBTA at the Site. The NRCPP project-specific surveys are performed in work areas before such activities as construction, mowing, assessment, remediation, and other projects start, and are instrumental in keeping Site activities in compliance with the acts and regulations listed above. Site-specific monitoring also provides data continuity with routine monitoring results.

A long-term ecological monitoring program such as the NRCPP ecological monitoring program plays an essential role in identifying fluctuations in wildlife populations, wildlife habitat use, and changes in the species that use the Site as year-round or seasonal habitat. Wildlife population densities vary because of natural pressures, and only long-term monitoring can identify "real" changes that are the consequence of either natural fluctuations or human influences. This information is essential for effective ecological resource management at the Site. The NRCPP also has the flexibility to add special surveys as needed for specific projects. Existing data in the database can then be combined with results from special surveys and analyzed to answer specific questions on ecological concerns. Availability of accurate, up-to-date ecological data is essential for planning long-term cleanup strategies. Additionally, advance knowledge of ecological concerns can help to avoid or minimize natural resource injury, thereby reducing liability for natural resource damages and establishing further credibility with regulators and the private sector.

Protection procedures and plans (DOE 1994b,c, 1997) developed and implemented by the NRCPP aid ecologists in assessing potential impacts to threatened, endangered, and special-concern species, as well as migratory birds and wetlands, all of which enjoy special protected status. Surveys performed in compliance with these procedures ensure that wildlife and wetlands are protected, and that state and federal wildlife and habitat protection statutes are not violated during Site activities.

The purpose of this ongoing, long-term program is to monitor, at a landscape level, the population trends and general health of the Rocky Flats ecosystem. The landscape-level monitoring approach—that of monitoring the entire Site as a single ecosystem unit—provides the appropriate level of information required for effective natural resource management at the Site. This landscape approach allows analysis of large habitat areas and site-wide trends, so that the effects of general Site operations can be assessed and management actions can be identified. Because most groups monitored include highly mobile species, this large-scale monitoring approach is necessary to provide more complete information on population and use trends. Smaller-scale monitoring would create data gaps when target species moved from sampling areas. Many species, or groups of species, use the entire Site or cross from one major drainage basin to another during various seasons, indicating that contiguous habitat units are of greater importance than drainage divides or artificial administrative divisions on the Site. Establishing artificial boundaries for monitoring, therefore, would limit data utility.

This report summarizes the results from wildlife surveys performed during 1998. Many survey techniques were used to determine populations and habitat use of wildlife species at the Site. The methods are outlined in the following section, and summaries of survey results for each major wildlife group monitored are presented in subsequent sections.

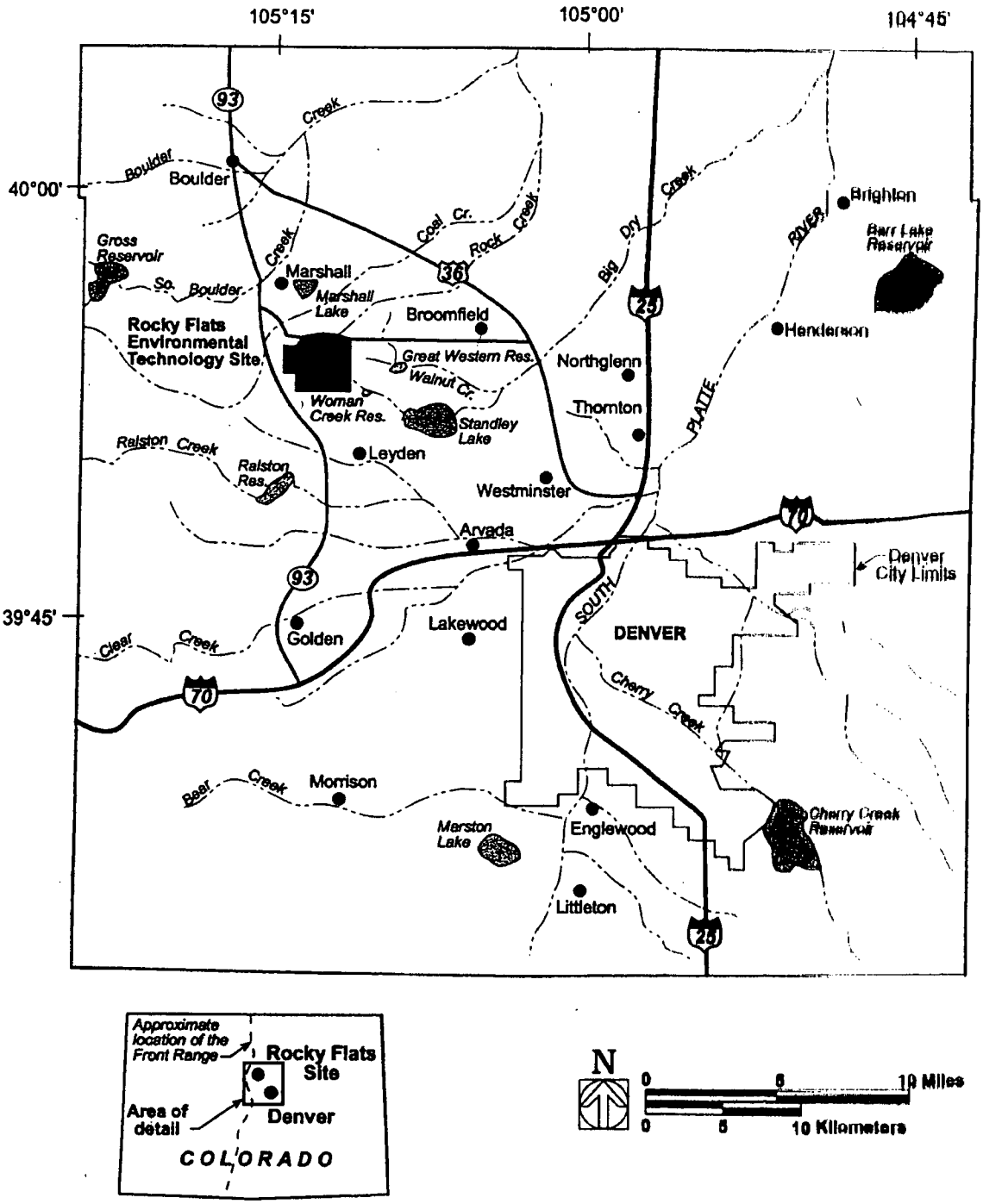


Figure 1-1. Location of the Rocky Flats Environmental Technology Site.

Section 2

Methods

2. Methods

Site ecologists use several methods to monitor the presence of wildlife, habitat use, seasonal residence, species densities, breeding areas, and other pertinent wildlife parameters. Significant species observations are recorded by grid location (Figure 2-1), whether observed during the sitewide significant species survey, multi-species census surveys, or migratory bird surveys. Multi-species census surveys, performed on established transects, record all wildlife observed. Monthly sitewide surveys along established roads over the entire Site record all significant species. Project-specific work-area surveys record the presence or absence of any special-concern species and confirm the presence and/or locations of wetlands within project areas. Migratory bird surveys record bird species along established transects. A limited fish sampling effort and an amphibian call-count survey were added into the program in 1998. In addition to these formal surveys, fortuitous sightings of any significant species are recorded (these may occur during the above surveys).

2.1 Data Collection

2.1.1 Significant Species Data Collection

Significant species are species of special interest because of their status as high-visibility species, indicator organisms, sensitive species, federal and state protected species, or game species. Significant species groups include waterfowl, big game mammals, game birds, carnivores, raptors (birds of prey), small game mammals, furbearers, and selected other species. When observations of significant species are made, location data are recorded by grid-cell code (Figure 2-1). The alphanumeric grid-cell locator code (e.g., 12H) provides a location to within 1,000 ft of the observation. A list of species currently designated as significant is presented in Appendix A.

2.1.1.1 Multi-Species Census Surveys

Multi-species census surveys are performed monthly on 16 established survey routes, allowing long-term data collection on survey transects included in the NRCPP ecological databases. Monthly performance of these surveys allows collection of data to characterize habitat and area use and estimate the relative abundance of significant species year-round. Transect routes vary in length (generally at least a mile) in all major habitat types at the Site. The major habitats recognized at the Site include wetlands, riparian (streamside) woodland, riparian shrubland, tall upland shrubland, mesic mixed grassland, xeric mixed grassland, and reclaimed grassland. Table 2-1 presents a list of transects and habitat descriptions for the multi-species surveys. See Figure 2-2 for transect locations.

Multi-species census surveys are performed in accordance with procedures described in the *EMD Operating Procedures Manual Volume V* (DOE 1994a). Surveys are performed by a qualified ecologist who walks established transects in specific habitats and records data for all animal species observed during the survey. Multi-species census surveys are designed to collect data on species richness, species abundance, area use, and habitat use. Data recorded include species, number of individuals, habitat, activities, age and sex classifications, and other pertinent information. Additionally, the habitat use per minute of observation time is recorded. These data provide information on what habitats were used by which species, how often, and for what purposes.

2.1.1.2 Sitewide Significant Species Surveys

Sitewide significant species surveys are conducted monthly along all main roads in the BZ. Preference is given to fair weather to optimize observation ability and driving conditions. During these surveys, all visible individuals of significant species observed during a short time span (i.e., 3 to 4 hours) over the entire property are recorded. These surveys are performed diurnally (during the day) and nocturnally (during the night).

In 1998, diurnal sitewide surveys were performed monthly, except in September, when the monthly survey was nocturnal (dusk to midnight). The nocturnal survey method provides coverage over the entire BZ in areas that can be seen with the beams of hand-held spotlights. The primary purpose of the nocturnal survey is to document the presence of nocturnal species that are rarely observed during daylight hours.

2.1.1.3 Fish Sampling

In 1998, fish sampling was performed systematically from the east boundary of the Site westward along each major drainage. Sample locations for the 1998 sampling season were selected on the basis of water availability sufficient to support fish. Ten locations per stream (40 locations across the Site) were sampled using minnow traps during this effort. The number of samples and the sampling locations depended entirely on stream and pool conditions at the time of sampling. Ponds were not sampled.

Traps remained at each location for a minimum of two days and were checked by afternoon of each day. Any aquatic or semi-aquatic vertebrates captured in the traps were identified and enumerated before being released.

2.1.1.4 Amphibian Monitoring

As a taxonomic group, the frogs and toads at the Site are only occasionally recorded during normal wildlife monitoring. Most observations have been fortuitous. Although this approach has provided an annual presence/absence record for these species at the Site, the lack of a repeatable monitoring methodology has prevented effectively tracking population abundance or the distribution of these species on Site. Such information could

provide additional insight and act as an additional tool for detecting changes in the health of the Site aquatic ecosystems, which currently receive limited ecological monitoring. Because their semi-aquatic nature makes them particularly sensitive to aquatic impacts, a regular monitoring effort for these species could provide additional information for monitoring ecosystem health and stress, and in detecting contaminants (Blaustein 1995).

In recent years, methodologies have been developed and instituted in eastern North America by Mossman et al. (1998), the Wisconsin Department of Natural Resources (Mossman and Hine 1984, 1985) and the National Biological Survey (NBS 1997) that use monitoring vocalization intensities as a method of determining population trends for frog and toad species. A small-scale sampling program was conducted during 1998 to evaluate the effectiveness of monitoring vocalizations by frogs and toads.

A set of 17 locations (Figure 2-3) were selected for sampling on Site. Because the calling periods for different species vary throughout the spring and summer, three separate sampling events were conducted to attempt to record the various species that might be calling on Site. The timing of each sampling event was determined by date and water temperature to match calling and breeding periods of different species. Surveys began at dusk, usually about 8:30 p.m., and finished about midnight. Specific methodology can be found in the 1998 Field Sampling Plans for Ecological Monitoring (K-H 1998b).

2.1.1.5 Project-Specific Special-Concern Species and Wetland Surveys

Special-concern species are a particular class of wildlife and plants that are of special interest at the Site because of their protected status or rarity. These species have been designated on the basis of their rare or imperiled status, as identified by the U.S. Fish and Wildlife Service (USFWS), the Colorado Division of Wildlife (CDOW), the Colorado Natural Heritage Program (CNHP), and other interested groups. Species placed in this category by the NRCPP are federally listed threatened and endangered species; species proposed by the USFWS for listing; species formerly listed by the USFWS as candidate species; Colorado threatened, endangered, or Species of Special Concern; species from the CNHP lists of rare and imperiled species; and species that are "watch-listed" by other regulatory or natural resource conservation groups. Special-concern species tracked by the NRCPP are listed in Appendix A. The NRCPP monitors the presence, locations, and numbers of these species within project areas to better ensure the Site's compliance with the applicable acts and regulations, and to provide appropriate protection for these species. If species of specific regulatory concern are found to be present in a project area, specific protection or avoidance plans are developed. When federally listed species will be affected, these surveys provide the basis for informal or formal consultation under the Endangered Species Act.

Project-specific surveys for special-concern species are performed in accordance with the ecology procedures 1-D06-EPR-END.03—threatened and endangered species protection (DOE 1994b), 1-G98-EPR-END.04—migratory bird protection (DOE 1994c), and 1-S73-ECOL-001—wetland protection (DOE 1997). Locations for project-specific surveys are determined by the work plans for construction, assessment, and remediation projects.

2.1.1.6 Fortuitous Observations

Fortuitous observations are chance observations of significant species during performance of other surveys not designed to target these species, or observations made during other activities. Such observations provide important information on species presence, and clues about habitat use, and location affinity, particularly for the rarer species at the Site.

2.1.2 Migratory Bird Surveys

Migratory bird species richness and population density data are collected along 20 permanent survey routes (transects) established in all major habitats at the Site. Surveys of these transects are performed by a qualified ecologist who walks the established routes and records data for bird species encountered along the survey belt. Table 2-2 lists survey routes and general habitat types for each transect. Figure 2-4 shows the locations of these routes. Migratory bird surveys collect habitat use and population data for all bird species in different habitats within the BZ. Breeding bird surveys collect the same data as monthly surveys, but are conducted at closely spaced time intervals (weekly) during early summer to provide greater detail on the breeding season. Monthly surveys are performed during the remainder of the year. Migratory bird surveys are performed in accordance with the *EMD Operating Procedures Manual* (DOE 1994a).

2.1.3 Protected Species Surveys (Preble's Meadow Jumping Mouse)

2.1.3.1 Trapping Methods

Trapping of Preble's meadow jumping mice and other small mammals follow the procedures outlined for small mammals in the *EMD Operating Procedures Manual Volume V* (DOE 1994a) and conform to the U.S. Fish and Wildlife Service *Interim Survey Guidelines for Preble's Meadow Jumping Mouse* (USFWS 1997). Different goals were addressed in different parts of the 1998 trapping program, so trap setup varied by location. See Appendix B for a detailed description of methodologies used during this trapping program.

Small mammal field efforts in 1998 concentrated on studying Preble's meadow jumping mouse (*Zapus hudsonius preblei*) populations in Walnut Creek and Rock Creek. Early and late trapping sessions were conducted in both creeks; however, the efforts in each creek addressed different goals. In Walnut Creek, the effort concentrated on confirming the presence of the Pond B-4 population.

The 1998 Rock Creek trapping was performed both in known occurrence areas and in new locations within the drainage. The Rock Creek field effort included two major components: 1) a mark-and-recapture study to estimate the population, and 2) a radio

telemetry tracking effort to monitor movements of individual mice within the drainage. These information needs were identified by Site ecologists as important to Site planning and conservation goals for the mouse, as well as providing an important contribution to the efforts of the statewide scientific team that is evaluating the Preble's mouse. Rock Creek was selected for the 1998 effort in keeping with the cyclical schedule called for by the Site's Integrated Monitoring Plan (IMP; K-H 1998a).

Data for each small mammal captured included species, age, sex, and breeding condition. Each Preble's mouse was measured for key identifying characteristics and examined for identification marks to determine whether it had been captured previously or was a new individual. Each individual Preble's mouse captured was marked with a Passive Integrated Transponder (PIT) tag. During subsequent recapture efforts, all Preble's mice were scanned with the PIT tag reader.

2.1.3.2 Radio Telemetry Methods

The field work for radio telemetry included conducting field trials of equipment, establishing telemetry monitoring stations, trapping mice and affixing collars, and finally, radio tracking individuals in the field. A detailed description of telemetry methods is provided in Appendix B.

First-session (spring 1998) telemetry tracking was conducted mainly at night, and second-session tracking was conducted during the daytime. Animals were located as often as possible, with a preliminary minimum of twice per night (or day). Field personnel avoided approaching or pursuing the collared animal, because observation of normal movements was essential. Readings on individual collar frequencies were taken from at least three monitoring stations, and a compass bearing for each reading was recorded. Bearings were mapped using an ArcView program developed by Ternary Spatial Research of Denver. The intersection of valid bearing lines approximated the transmitter's location. The Universal Transverse Mercator (UTM) coordinates of the estimated points were calculated by the program, and entered into a telemetry database.

2.1.3.3 Habitat Characterization

Habitat was characterized at the trap station (microsite) level. Within Rock Creek sites, microsite habitat was characterized only where Preble's mice had not been captured previous to 1998 or where nesting was documented. Because the Walnut Creek effort was intended to establish presence/absence, no habitat characterization was conducted there.

Where a Preble's mouse was captured in a new area, the habitat was characterized on the basis of 10 trap stations (including Preble's mouse capture points) for each transect. Nesting sites were characterized using the same data collection methods for a single point. Detailed methodology is described in Appendix B.

2.2 Data Analyses

As standard practice, data entry into the Ecological Database is verified and validated to ensure accuracy before data analysis is performed. Corrections are made to entered data as required, and all summary tables used for data analysis are based on the quality-assured data (K-H 1997b).

2.2.1 Multi-Species Census Data Analyses

The Ecological Database was queried to determine the habitat use preferences of each species of interest and the relative abundance of those species. Summary tables for species and/or species groups were then prepared, and the percentages of observations in each habitat were compared to determine habitats of major importance to individual species or species groups, and to determine the relative abundance of those species.

Relative abundance, expressed as observations per minute (o/m), is a means of comparing the abundance of a particular species to itself over time, or comparing relative abundance of one species to another. These comparisons can be made within a single habitat, or a single season, over the entire Site by season or by year. By comparing relative abundance, one can determine how common (or relatively abundant) a species is in specific habitats by season or by year, and how common each recorded species is site wide. A comparison of relative abundance over time can provide specific information on long-term population trends. While relative abundance cannot provide absolute population numbers, the relative abundance of species provides information on trends. For example, when results for a given species are compared year to year (e.g., mule deer relative abundance of 0.201 o/m in Year A compared to 0.119 o/m in Year B, showing a decline in relative abundance) a trend in relative abundance will indicate a trend in the population of that species. Further, if mule deer are recorded at a rate of 0.119 o/m, and turkey vultures are recorded at a rate of 0.0002 o/m, the data show that mule deer are more abundant than turkey vultures. A comparison of observations per minute of a species in a given habitat to observations per minute of that species in another habitat can provide information on the habitat affinities of that species. Each type of information is valuable in determining management strategies for either individual species, or for different habitats, depending on the management need.

2.2.2 Significant Species Area Use from Sitewide Surveys Data Analyses

Area use summaries were derived by querying the sitewide significant species survey data in the Ecological Database for grid points from observations of each species. Figure 2-1 shows the grid used to record location data. Summary tables were then prepared to facilitate data analyses for each major species group.

2.2.3 Fish Sampling Data Analyses

Analyses for these semi-quantitative sampling methods were limited to enumeration of species identified for each stream (i.e., species richness).

2.2.4 Amphibian Monitoring Data Analyses

Data from the three sampling events were summarized for species richness, frequency, and vocalization indices for each species. In addition, a map was prepared showing where the species were documented on Site in 1998.

2.2.5 Bird Community and Species Density Analyses

Quality-assured data sets from 1991 and 1993–1998 were analyzed using four community measures: species richness, species diversity, population density, and community similarity. A modified Simpson's Index was used as a measure of diversity (Hair 1980). Bird density was calculated as number of individuals per square kilometer for each species. This calculation used the total transect length by 50 m on each side of the transect (100 m wide). Comparisons of bird community similarity were based on the Jaccard coefficient of similarity (Digby and Kempton 1987).

Calculations were done by habitat, as well as for sitewide observations, for the entire year and for specific seasons. The data sets were standardized to eliminate observations beyond 50 m on either side of the transect line. Observations beyond 50 m are considered less reliable in terms of the number of individuals observed and may not be representative of bird communities in linear habitats (e.g., riparian woodlands). Additionally, the data sets were modified to eliminate random "flyover" observations. Flyovers are observations of birds in flight above the transect (Table 2-3).

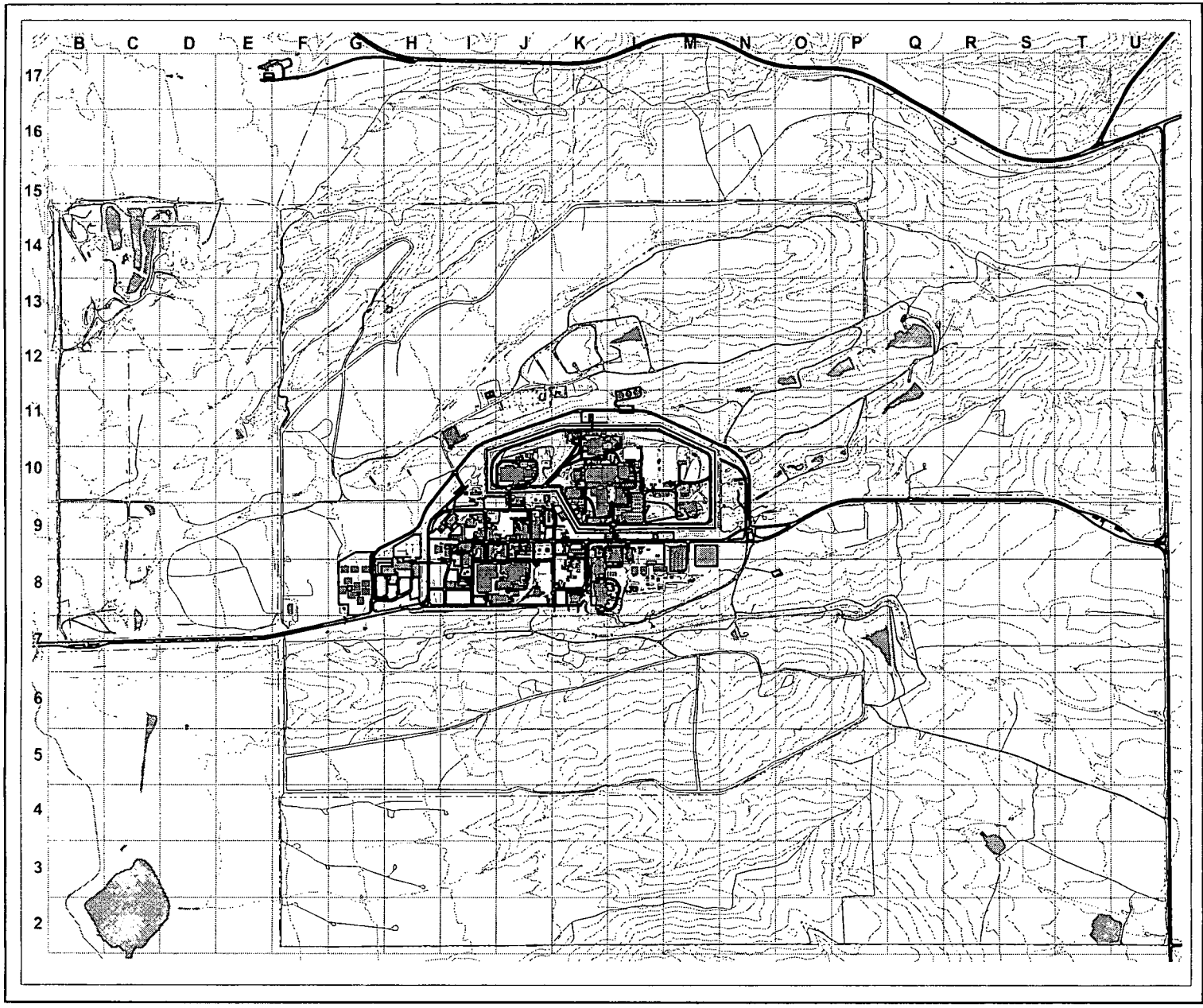
2.2.6 Preble's Meadow Jumping Mouse Data Analyses

Data analyses for the 1998 Preble's mouse monitoring results were divided into four major categories: presence/absence at trapping locations, population estimation, movement patterns based on radio telemetry, and habitat characterization.

Presence/absence was a simple yes or no determination of the mouse's presence at each trapping grid. Because there were insufficient numbers of Preble's mice captured and recaptured in Rock Creek during the 1998 monitoring effort, and because mice moved more widely than anticipated, population estimates using mark-recapture methods were not used. Instead of using 1998 data from Rock Creek, density estimates from past years' trapping (1994–1996) were used, along with habitat information, to estimate Rock Creek populations.

Movement pattern analyses were based on radio telemetry and included travel distances and apparent area usage patterns. Calculations were made for daily (i.e., over a 24-hour observation period) and monthly maximum and average movements of individuals, as well as maximum perpendicular distance from the stream observed for each collared individual. Because data were in the form of triangulated points, and not real-time tracked movement, travel routes were estimated. Home range estimates using the Jennrich-Turner bivariate normal home range estimator were also calculated using a 90 percent probability ellipse (Jennrich & Turner 1969).

The habitat endpoints were used to characterize Preble's mouse habitat in new capture areas. New capture sites were compared to the current Site habitat model parameters. Additionally, comparisons of the habitat endpoints were made between years, where appropriate.



Rocky Flats grid.

Figure 2-1.

MAP LEGEND

Rocky Flats grid

Standard Map Features

- Dirt roads
- Paved Roads
- Streams
- Fences
- Contours (25 ft)
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

N

1:32765

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-rfets grid map

April 27, 1999

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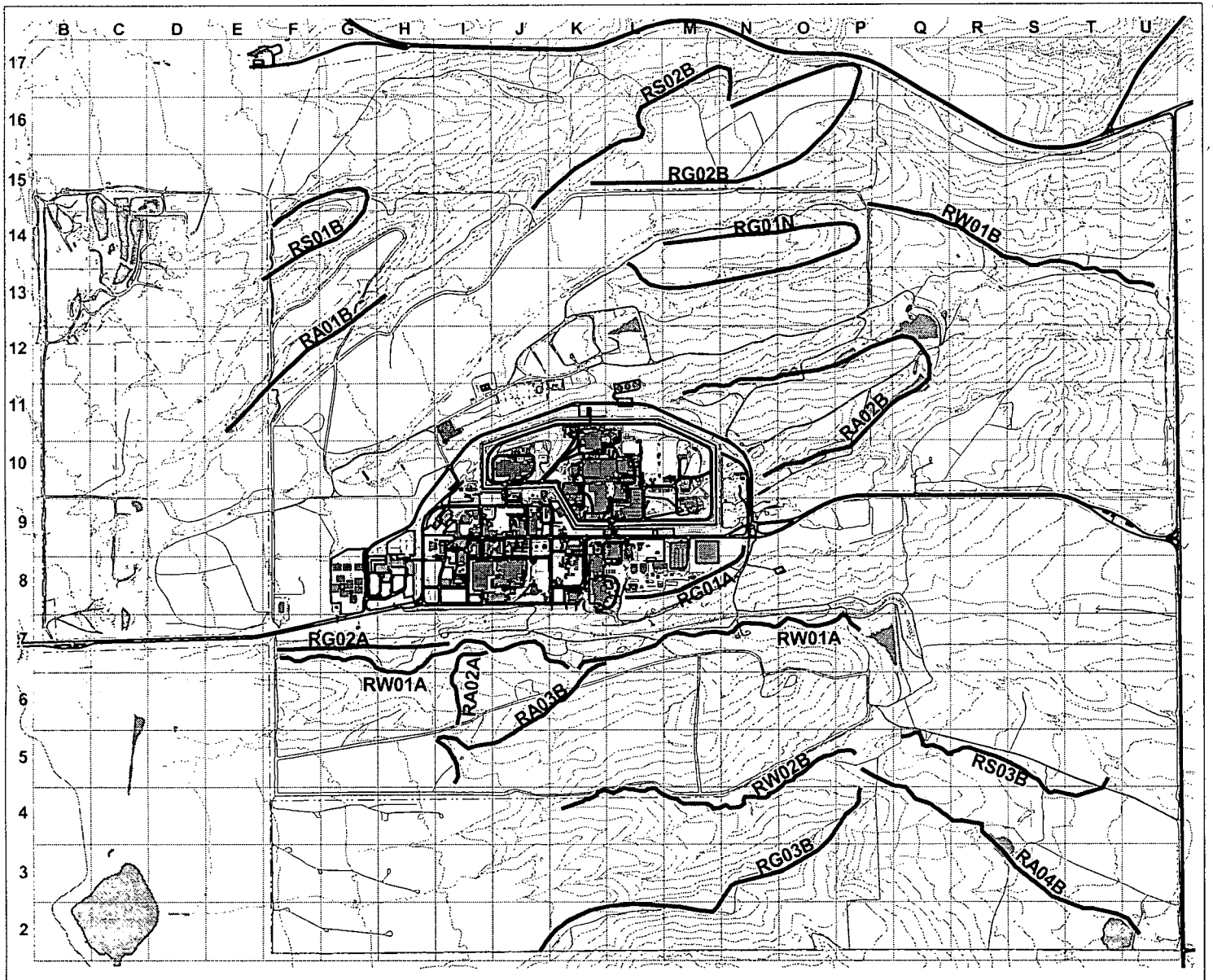

Locations of multi-species census survey transects.

Figure 2-2.

MAP LEGEND

multi-species survey transects

Rocky Flats grid

Standard Map Features

Dirt roads
Paved Roads
Streams
Fences
Contours (25 ft)

Buildings
Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

1:32765

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-rfets grid map

April 27, 1999

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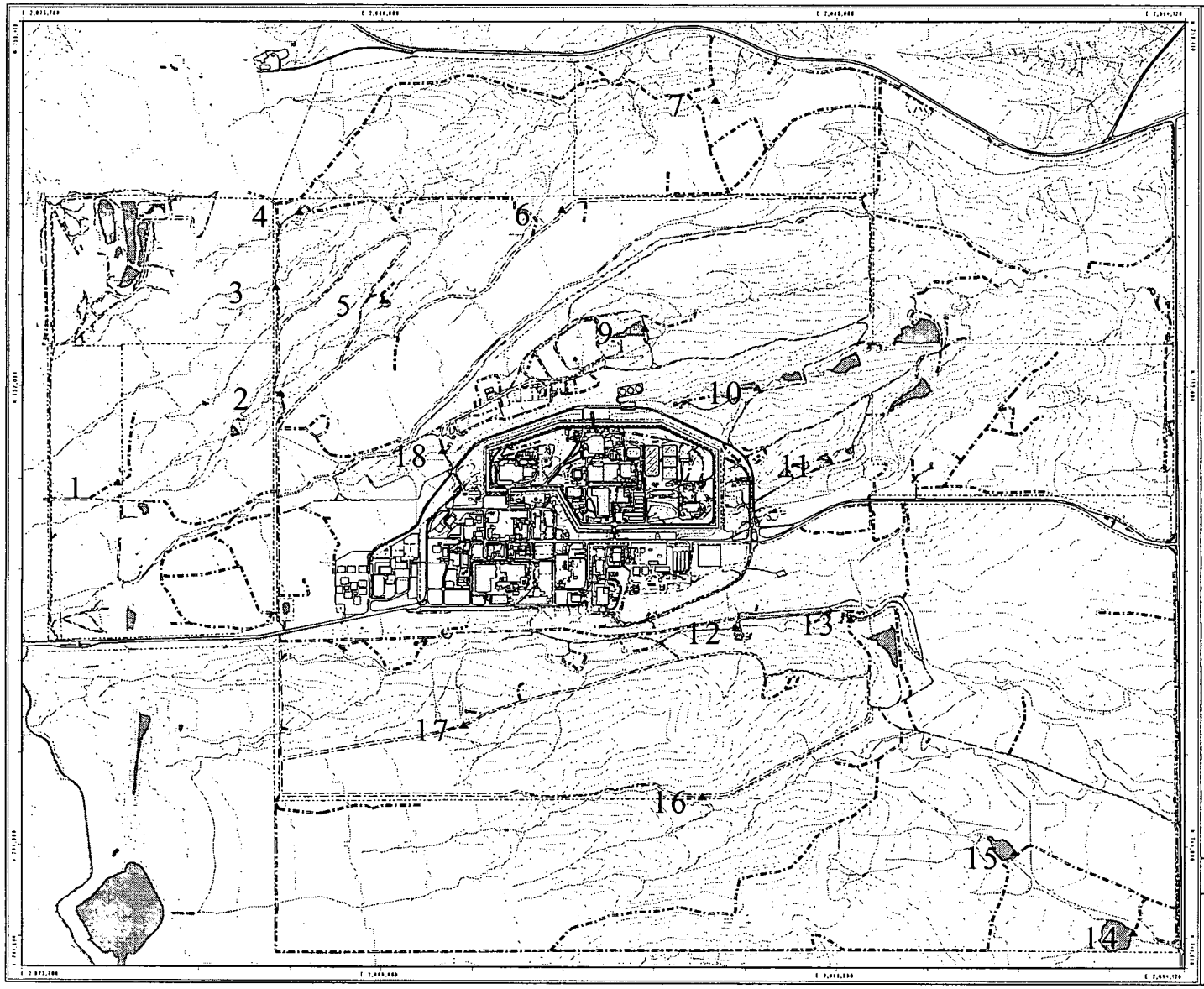

1998 Frog and Toad Vocalization Survey Locations
Figure 2-3

EXPLANATION

▲ Frog and Toad Vocalization Survey Locations

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
1998 Frog and Toad Vocalization Survey
Locations provided by Rocky Flats Environmental Group facilities and engineering

N

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000 Ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
Exponent

MAP ID: /home/r519655/ August 26, 1999

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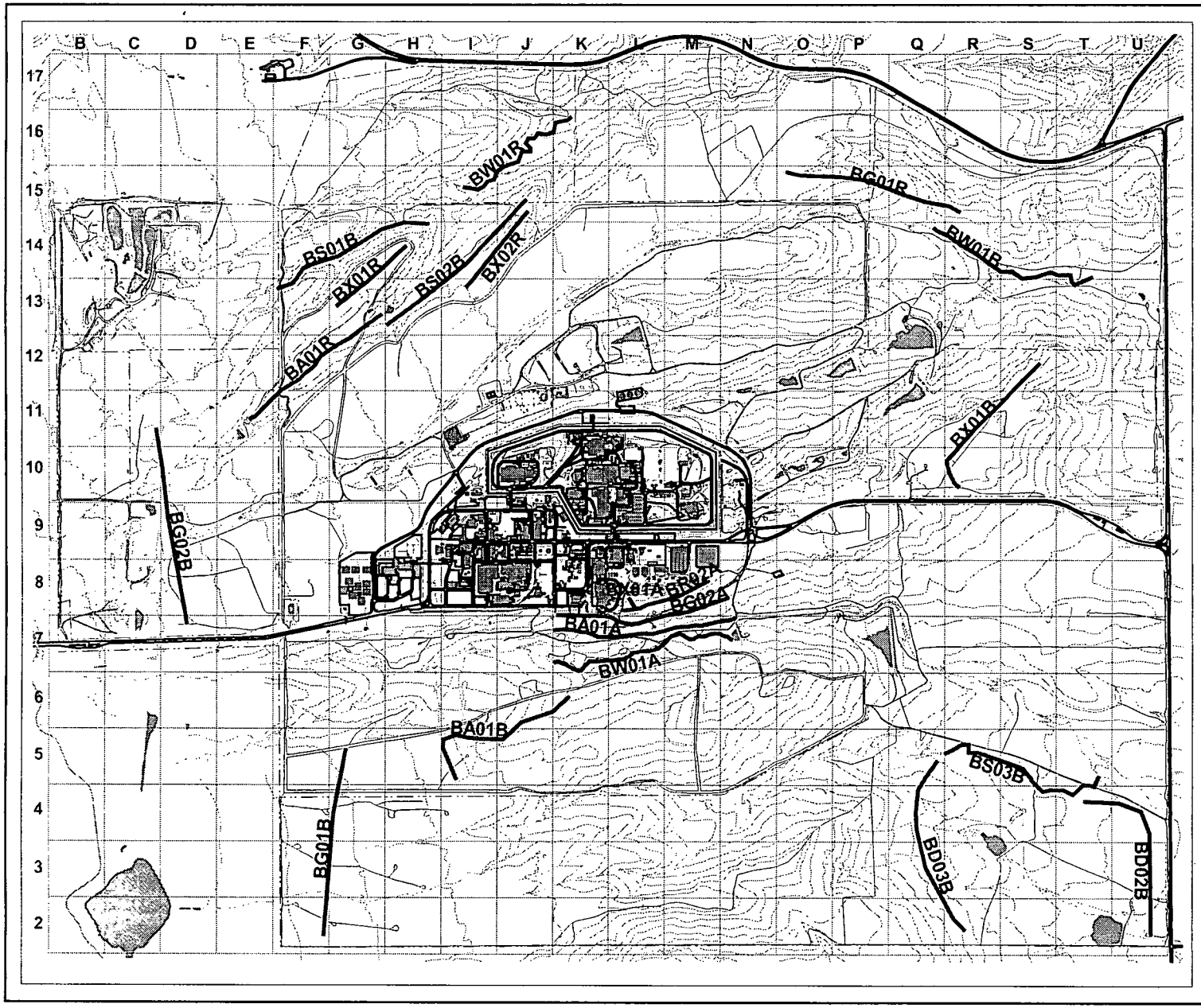

Locations of bird survey transects.

Figure 2-4.

MAP LEGEND

- bird survey transects
- Rocky Flats grid

Standard Map Features

- Dirt roads
- Paved Roads
- Streams
- Fences
- Contours (25 ft)
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

1:32765

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-rfets grid map

April 27, 1999

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Table 2-1. Multispecies census survey transects

Transect Number	Dominant Habitats Along Transect
RA01B	Wet Meadow (010), Short Marsh (020), Tall Marsh (030), Impoundment (054), Stream Pool (043)
RA02A	Wet Meadow (010), Short Marsh (020), Tall Marsh (030)
RA02B	Tall Marsh (030), Impoundment (054), Mudflats (093), Riparian Woodland (110), Mesic Grassland (322)
RA03B	Wet Meadow (010), Short Marsh (020), Tall Marsh (030)
RA04B	Wet Meadow (010), Short Marsh (020), Tall Marsh (030), Impoundment (054), Reclaimed Grassland(324)
RG01A	Reclaimed Grassland (324)
RG02A	Riparian Woodland (110),
RG02B	Xeric Grassland (323), Mesic Grassland (322)
RG03B	Xeric Grassland (323), Mesic Grassland (322)
RS01B	Tall Upland Shrubland (230), Mesic Grassland (322)
RS02B	Short Marsh (020), Tall Upland Shrubland (230), Mesic Grassland (322)
RS03B	*Amorpha* Riparian Shrubland (211), Riparian Woodland (110)
RW01A	Riparian Woodland (110), *Salix* Riparian Shrubland (212)
RW01B	Riparian Woodland (110), *Salix* Riparian Shrubland (212), Wet Meadow (010)
RW02B	Riparian Woodland (110), *Salix* Riparian Shrubland (212), Wet Meadow (010), Short Marsh (020)
RW03B	Riparian Woodland (110), *Salix* Riparian Shrubland (212), Amorpha Riparian Shrubland (211)

Table 2-2. Bird survey transects

Transect Number	Transect Length	Dominant Habitats Along Transect
BA01A	1000 m	Tall Marsh (030)
BA01B	1000 m	Wet Meadow (010), Short Marsh (020), Tall Marsh (030), Stream Pool (043)
BA01R	1000 m	Wet Meadow (010), Short Marsh (020), Tall Marsh (030), Stream Pool (043)
BD02B	1000 m	Reclaimed Grassland (324)
BD03B	1000 m	Reclaimed Grassland (324)
BG01B	1000 m	Xeric Grassland (323)
BG01R	1000 m	Mesic Grassland (322)
BG02A	1000 m	Mesic Grassland (322), Reclaimed Grassland (324)
BG02B	1000 m	Xeric Grassland (323), Mesic Grassland (322)
BR02A	500 m	Reclaimed Grassland (324)
BS01B	1000 m	Tall Upland Shrubland (230), Mesic Grassland (322)
BS02B	1000 m	Short Marsh (020), Tall Upland Shrubland (230), Mesic Grassland (322)
BS03B	1000 m	*Amorpha* Riparian Shrubland (211), Riparian Woodland (110)
BW01A	1000 m	Riparian Woodland (110), *Salix* Riparian Shrubland (212)
BW01R	1000 m	Riparian Woodland (110), *Salix* Riparian Shrubland (212)
BX01A	100 m	Recovering Xeric Grassland (323)
BX01R	500 m	Xeric Grassland (323)
BX02R	500 m	Xeric Grassland (323)
BX01B	1000 m	Xeric Grassland (323)
BW01B	1000 m	Riparian Woodland (110), *Salix* Riparian Shrubland (212)

Table 2-3. Species for which flyover observations were included in analyses

Type	Common Name	Scientific Name
Nighthawks		
	Common Nighthawk	*Chordeiles minor*
	Common Poorwill	*Phalaenoptilus nuttallii*
Raptors		
	American Kestrel	*Falco sparverius*
	Bald Eagle	*Haliaeetus leucocephalus*
	Cooper's Hawk	*Accipiter cooperii*
	Ferruginous Hawk	*Buteo regalis*
	Golden Eagle	*Aquila chrysaetos*
	Merlin	*Falco columbarius*
	Northern Goshawk	*Accipiter gentilis*
	Northern Harrier	*Circus cyaneus*
	Osprey	*Pandion haliaetus*
	Peregrine Falcon	*Falco peregrinus*
	Prairie Falcon	*Falco mexicanus*
	Red-tailed Hawk	*Buteo jamaicensis*
	Rough-legged Hawk	*Buteo lagopus*
	Sharp-shinned Hawk	*Accipiter striatus*
	Swainson's Hawk	*Buteo swainsoni*
	Turkey Vulture	*Cathartes aura*
Swallows and Swifts		
	Barn Swallow	*Hirundo rustica*
	Black swift	*Cypseloides niger*
	Cliff Swallow	*Hirundo pyrrhonota*
	Northern Rough-winged Swallow	*Steigidopteryx serripennis*
	Tree Swallow	*Tachycineta bicolor*
	Violet-green Swallow	*Tachycineta thalassina*

Section 3

Results and Discussion

3. Results and Discussion

The following sections present summaries of wildlife monitoring performed under the NRCPP during 1998. Comparisons with previous years are made in the discussions for each species group. Many of the data are summarized by season. For the purpose of this document, seasons are defined as spring (March through May), summer (June through August), fall (September through November), and winter (December through February).

3.1 Significant Species

Significant species monitored during 1998 included big game mammals, large rodents and lagomorphs, carnivores, waterfowl, raptors, fish, herptiles (reptiles and amphibians), and special-concern species. A list of the species included in these groups is provided in Appendix A. The data entry codes for significant species are also described in Appendix A. Discussions in the following sections concentrate on the various significant species groups.

A special effort was also made to monitor the Preble's meadow jumping mouse population in Rock Creek. Preble's mice were federally listed as a threatened species in May 1998. Radio telemetry was used to monitor Preble's mouse movement in an attempt to better understand how they use their habitat, and to gain additional information on home range. The results of this sampling effort are summarized below in Section 3.1.8.5, and are presented in total in Appendix B.

It should be noted that two types of surveys (as discussed in Section 2) were used in collecting data on the significant wildlife groups discussed below. Sitewide significant species surveys recorded primarily area use, but they also recorded instantaneous habitat use for all significant species observed in a short time span over the entire Site. Multi-species census surveys provided data on habitat use per unit time of observation along permanently established walking transect lines. Results from both methods are discussed below.

3.1.1 Big Game Mammals

The most common big game species at the Site is the mule deer (*Odocoileus hemionus*). The current population at the Site is estimated at 120 individuals. This estimate is based on a winter deer count, extrapolated to take into account the well-known fact that ungulate herds are routinely underestimated (Wallmo 1981). Site knowledge allows the ecologists to extrapolate observed numbers to a population estimate based on assumed underestimation from some areas of the Site. Elk (*Cervus elephas*) were recorded twice during multi-species surveys, and once fortuitously on the Site in 1998. Habitat use

varied from tall marsh to tall upland shrubland. Relative abundance of mule deer by habitat is discussed in Section 3.1.2.2.

White-tailed deer (*Odocoileus virginianus*) continue to populate the Site in small numbers. White-tailed deer does have been observed more often with herds of mule deer than in the past. During the baseline characterization (DOE 1992), no white-tailed deer were recorded, but observations have increased in recent years to several per year. At present, a group of six individuals is observed periodically in lower Woman Creek and Smart Ditch. From one to several individuals have been observed commingling with mule deer more commonly than in the past, and white-tailed deer were observed in the Rock Creek drainage several times in 1998. The species may be expanding its range onsite. Most previous observations had been in the lower Woman Creek area. The two deer species do hybridize, and several hybrids have been observed on the Site since 1991. This may become a future management concern for the Site, because such hybridization could affect the long-term viability of the Site's mule deer herd. The population trend of white-tailed deer thus bears further observation.

3.1.1.1 Sitewide Significant Species Surveys—Big Game

Winter Deer Count Comparison—A sitewide survey was conducted on January 21, 1999 for the purpose of obtaining a year-end 1998 population census for big game. The year-end census is weather dependent, requiring snow-covered ground to provide the best visibility for the most accurate count. This census is typically conducted during the last week of December of the survey year, or as soon as appropriate snow cover is available in January. A snowfall on January 21 provided the required conditions for the year-end count

The census survey recorded 106 mule deer and two white-tailed deer does. Because the success of winter surveys such as this are weather dependent, often not all deer present at the Site are visible to observers or identifiable by age and sex. Therefore, not all deer are counted or divided into age/sex classes. The winter count has fluctuated since 1994, when the highest count of 164 deer was recorded. Figure 3-1 shows the winter mule deer population trend from 1994 to 1998.

The age class breakdown continues to indicate a fawn survival rate of approximately one fawn for every two does (1:2). The number of fawns recorded in the year-end census (25) was approximately 84 percent of the mean winter fawn count over the past five years. It should be noted that censuses of mule deer normally yield low counts of fawns (Wallmo 1981). Although opinions vary among mule deer population authorities, a fall-season fawn-to-adult ratio of 30:70 is considered to be optimum for maintaining the herd (Fitzgerald et al. 1994). The year-end census showed 24 percent of the population as young of the year, and some individuals likely went unrecorded. This number cannot be correlated directly to a fall count, because some winter kill occurs among deer herds during late fall and through the winter. A fall-season count in October 1998 recorded

only half the winter count, but in similar proportions (28 percent young, 26 percent bucks, 46 percent does).

The number of bucks counted in the year-end census (22) was only about half that in December 1997 (42), but the ratio of does (59) to bucks remained the same (2.7:1), showing a good balance for a healthy herd. According to Wallmo (1981), a sex ratio of approximately two adult does per one adult buck indicates a very healthy mule deer population. The variations in mule deer numbers recorded at the Site probably represent normal population fluctuations, but other wildlife professionals, especially Site visitors from the Colorado Division of Wildlife, generally are encouraged and impressed with numbers at the Site. Figure 3-2 shows the age- and sex-class breakdown of the mule deer population from 1994 to 1998.

The number of deer observed during the year-end count (approximately 0.04 deer/ha, or 11 deer/mi^2) has declined somewhat since 1997 (13 deer/mi^2). This apparent change may be due to unfavorable weather conditions for optimum visibility during the survey. A light snowfall reduced visibility and made some roads inaccessible, and the lack of snow cover made deer more difficult to see at distance. The relatively large mule deer population at the Site is due to good range condition and the protection afforded them by the prohibition of hunting within Site boundaries. The lack of constant disturbance in the BZ also provides protection from stress, and normally promotes a good fawn survival rate.

Big Game Area Use Summary—In this section, monitoring data from 1998 sitewide significant species surveys are summarized by season (spring, summer, fall, and winter). These surveys were performed once each month from all passable roads in the Buffer Zone, thus providing 12 "snapshot" area use records for the year. Area use data are an important tool used by Site ecologists in helping project planners time disruptive activities to avoid critical periods or essential habitat. Seasonal summaries of mule deer use at the Site reflect the species' strong year-round preference for some locations and seasonal preferences for other locations. Figure 3-3 shows areas of critical importance to the Site mule deer herd. This map is based on data summaries of area use since 1991. This map is intended to provide a better understanding of mule deer use patterns at the Site, and to illustrate how a single, mobile species uses the entire Site as habitat. The 1998 area use data summary for mule deer is provided in Table 3-1.

The use patterns reflect two apparent area preference criteria. One preference is for specific seasonal habitat that meets certain survival requirements (e.g., protective cover for new fawns). A second important area preference is for secluded areas. Some areas preferred by the deer do not provide unique habitat but do offer isolation from disturbance. Figures 3-4 through 3-7 show area use for the four seasons in 1998. There were no remarkable changes in area use in 1998.

Mule Deer Spring Area Use: During the spring of 1997, mule deer area use at the Site mirrored longer-term use patterns (Figure 3-4) discussed in previous reports (RMRS 1996; K-H 1997c; K-H 1998c). Group sizes varied from 1 to 31 individuals, sometimes

reflecting weather conditions. Snow-free, south-facing hillsides (where green-up occurs earliest) were most preferred, as were locations providing the best refuge and thermal cover from residual winter storms that are common during March and April. Several areas in the xeric tallgrass prairie community were also used frequently when the weather was not severe.

Mule Deer Summer Area Use: The summer mule deer area use patterns in 1998 also mirrored those found in previous years (Figure 3-5). Area use during the summer was quite dispersed, with high use recorded in the upper Rock Creek shrublands and riparian woodland portions of Woman Creek, Walnut Creek, and Smart Ditch (from multi-species census surveys, 69 percent of the observations were in these two habitats). At the start of the summer season (June), fawning occurs, and by the end of the season (August), the young of the year are gaining independence. Areas of heavy concentration are limited in extent, and reflect heavy use by does with fawns or by buck groups. Adequate cover to conceal young, and isolation and security, are requirements for fawning habitat (WGFD 1985). Does with dependent fawns show a strong preference for areas with tall upland shrubland and riparian woodland habitats such as are found in upper Rock Creek and along the bottomland areas of the Woman Creek and Smart Ditch drainages. Rock Creek's tall upland shrubland habitat is ideal for fulfilling these requirements. Bucks are drawn to areas that provide seclusion and shade cover during this season. These areas include Rock Creek shrubland units, and areas in the Smart Ditch drainage basin. Mature bucks are seldom found in the company of does with young during this season (see Table 3-1 for a data summary).

Mule Deer Fall Area Use: Mule deer use patterns during the fall of 1997 were similar in location and extent to the spring use patterns. These, too, mirrored the longer-term use summaries presented in previous annual reports (RMRS 1996; K-H 1998c). Group sizes ranged from 1 to 15. Certain areas of xeric tallgrass prairie, tall upland shrubland, and riparian habitats were high-use areas (Figure 3-6), reflecting the tendency of the species to concentrate in these areas during the November breeding season (the rut). During the rut, large mixed-sex groups of mule deer are observed frequently in the open grassland areas, often at the same location for several days at a time (see Table 3-1 for a data summary).

Mule Deer Winter Area Use: Winter mule deer area use at the Site during 1998 was fairly dispersed, with preferences shown for upper Rock Creek, the Woman Creek and Smart Ditch bottomlands, and the lower Walnut Creek grasslands (see Figure 3-7). A pattern of use on south- and southeast-facing mesic grassland hillsides was evident. Some winter use patterns clearly reflect the thermal advantages provided by the preferred areas. Other winter use areas provide better quality, or more available forage, with reduced procurement effort (i.e., a better energy return for the effort). Upper Rock Creek, for example, provides refuge from the frigid northwest winds of the winter months because of its steep topography, narrow valleys, and orientation perpendicular to the prevailing winter winds. South- and southeast-facing slopes provide the greatest incident thermal energy, as well as the best snow-free forage areas. Even as early as late January,

many of the early forbs and grasses on these slopes are greening up for spring growth, providing good early-season forage.

White-Tailed Deer Area Use: White-tailed deer have been observed as single individuals with mule deer groups in widely scattered areas from upper Rock Creek to lower Walnut Creek and lower Woman Creek. White-tailed bucks are observed most consistently with small white-tailed deer groups in lower Woman Creek and lower Smart Ditch, although in 1998, one buck was also recorded in upper Rock Creek (Table 3-1).

3.1.1.2 Mule Deer Relative Abundance by Habitat from Multi-Species Census Surveys

Overall annual mule deer relative abundance was 0.119 observations per minute of survey (o/m). Mule deer habitat use varied by season and by habitat (Table 3-2). Mesic mixed grasslands were most heavily used in winter, with a seasonal relative abundance of 0.796 o/m (54 percent of use), and spring, with 0.850 o/m (45 percent of use). Riparian woodland/shrubland (43 percent, 0.023 seasonal o/m) and tall upland shrubland (26 percent, 0.014 seasonal o/m) was most heavily used in summer. During fall, relative abundance of mule deer was highest in riparian woodland/shrubland (43 percent, 0.068 seasonal o/m), tall upland shrubland (19 percent, 0.026 seasonal o/m), and mesic mixed grassland (14 percent, 0.020 seasonal o/m). The greatest variety of habitats (13) were used during the summer and fall, with six in spring, and eight in winter. Mule deer relative abundance varied throughout the year, with sitewide relative abundance ranging from 0.152 o/m in spring to 0.054 o/m in summer.

3.1.1.3 White-Tailed Deer Habitat Use from Multi-Species Census Surveys

Habitat use summaries based on multi-species census surveys (Table 3-2) indicate that white-tailed deer use both shrublands and grasslands at the Site. White-tailed deer were in small groups of their own, or in company with groups of mule deer. During 1998, small groups (2–6 individuals) of white-tailed deer continued to use the lower Smart Ditch/lower Woman Creek area. Single does were observed most often with mule deer groups in various parts of the Site. The present total population at the Site may be as many as 10 to 15 animals. The sitewide annual relative abundance of white-tailed deer in 1998 was 0.002 o/m.

3.1.2 Lagomorphs and Large Rodents (Sitewide and Multi-Species Surveys)

The most commonly observed lagomorph (rabbit or hare) at the Site during 1998 was the desert cottontail (*Sylvilagus audubonii*), with a mean sitewide annual relative abundance of 0.001 observations per survey minute. White-tailed jackrabbits (*Lepus townsendii*) and black-tailed jackrabbits (*Lepus californicus*) have been recorded, but individuals of both species are seldom observed, and during sitewide significant species surveys and

multi-species census surveys, only tracks were observed during 1998. Desert cottontails, as in previous years, were most abundant in disturbed areas, scrap storage areas, trailer yards, storage areas, rip-rap areas, and other areas affording cover. Jackrabbit sign was also found near disturbed areas, but jackrabbits were more abundant in xeric mixed grasslands at the Site. Table 3-3 provides a summary of recorded seasonal habitat use and relative abundance by habitat for these species, based on multi-species census surveys. The 1998 area use data summary, based on sitewide surveys, is provided in Table 3-4.

Muskrats (*Ondatra zibethicus*) were recorded in impoundments (ponds), most often in association with cattails (*Typha* sp.), during 1998. Populations of this species are difficult to estimate without a heavy trapping regimen, but observations in 1998 confirmed the continued presence of the species in appropriate habitat. Table 3-4 summarizes recorded area use by this species.

One porcupine (*Erethizon dorsatum*), now a protected species within the State of Colorado, was observed in a riprapped portion of McKay Ditch, apparently in transit between food sources. This was the first recorded observation outside the Rock Creek drainage. Tracks in the snow indicated that a porcupine was also continuing to use the old Lindsay Ranch house (grid 13E) as a denning site. The porcupine's preferred forage species at the Site are hawthorn (*Crataegus sp.*), chokecherry (*Prunus virginiana*), and ponderosa pine (*Pinus ponderosa*), all of which are most abundant in upper Rock Creek. The presence of this species at the Site is significant, because it verifies that the habitats at the Site are sufficiently diverse to support such increasingly rare species.

Black-tailed prairie dog (*Cynomys ludovicianus*) populations in the vicinity continue to rebound from the regional die-off in 1994 that was caused by the plague epizootic. Prairie dogs were once established in several colonies at the Site, and have continued to repopulate some historical colony areas. By the end of 1998, prairie dogs were once more evident in three former colonies. Until populations rebound to previous densities, specific prairie dog censuses are unnecessary.

Prairie dog populations at the Site are of interest, because the number of wintering raptors that can be supported by the Site is directly correlated to the prairie dog population. Prairie dogs are considered a "keystone" species in the prairie ecosystem, acting as a prey base for a number of mammalian and avian predators. When their numbers decline, these predatory species also suffer declines in population. Long-term nesting success of the Standley Lake bald eagle pair may ultimately depend on sufficient prairie dog populations in the vicinity, including any populations at the Site.

3.1.3 Carnivores (Sitewide and Multi-Species Surveys)

The most frequently observed carnivore species at the Site is the coyote (*Canis latrans*), and the next is the raccoon (*Procyon lotor*). Coyotes, which are active both diurnally and nocturnally, were found in all habitats, but were most visible in marshlands and grasslands as they hunted small mammals during the day. Mean annual sitewide relative

abundance for coyotes was 0.007 observations per minute of survey time (the 1997 mean was 0.008 o/m). Relative abundance values ranged from 0.010 o/m in winter to 0.003 o/m in spring. Differences in observation rates may have been influenced by vegetation density, because high vegetation in spring and summer reduces the species' visibility.

Four coyote dens and several juveniles were observed in 1998, confirming that the Site's coyotes successfully reproduced during the year. Typically, three to four coyote natal dens are located each year at the Site. The estimated number of coyotes on the Site, based on results from sitewide surveys and Site knowledge, remains at approximately 14–16 individuals. Table 3-5 provides a seasonal habitat use summary for carnivores in 1998 based on multi-species census survey data. This summary presents primarily coyote relative abundance, because most other species are nocturnal and are seldom observed during daytime surveys. The 1998 area use data summary, based on sitewide significant species surveys, is provided in Table 3-6.

Raccoons are largely nocturnal, and are therefore most frequently documented from tracks or through small-mammal trapping activities. (Site ecologists often intentionally live-trap raccoons to remove them from the vicinity of small-mammal traplines, because of the raccoons' penchant for robbing bait from the traps.) Raccoons or their sign were observed fortuitously in both the Industrial Area (IA), where they frequented areas with food refuse, and the BZ near riparian channels and pond margins. The limited number of observations precludes making an accurate population estimate.

Mountain lion (*Felis concolor*) tracks were recorded during three different multi-species census surveys. Each record was of a solitary animal. Habitats where the tracks were found included both grassland and shrublands.

The presence of several mammalian carnivore species, the top species in the food chain, is an indication of the good ecological condition of the Site. While this program does not attempt to track numbers of all carnivores at the Site, the estimate of steady coyote population over time is a good indication that prey species continue to be abundant. The top carnivores in an ecosystem must have a large, healthy population of prey species upon which to subsist. Reduced numbers of prey species are normally reflected in reduced species richness of carnivores.

3.1.4 Waterfowl—Ducks, Geese, and Shorebirds (Sitewide and Multi-Species Surveys)

As would be expected, the majority of the 28 waterfowl species observed during sitewide significant species surveys and multi-species census surveys were concentrated around the impoundments (ponds). Habitat use reflected the strong preferences for open water, pond-margin mudflats, and associated wetlands (Tables 3-7 through 3-12). Area use varied somewhat between the fall/winter and spring/summer seasons. Fall/winter area use was heavily concentrated on the major impoundments at the Site, while spring/summer use was more dispersed. Some observations during the breeding season

occurred along creeks, in ditch and creek pools, and in greening-up grasslands. For the first time in several years, northern pintails (*Anas acuta*) have reappeared at the Site. Fourteen species of waterfowl have been documented as breeders or suspected breeders at the Site.

Most waterfowl and shorebirds were observed on the large impoundments at the Site. Diving ducks, such as buffleheads (*Bucephala albeola*), common (*Mergus merganser*) and hooded merganser (*Lophodytes cucullatus*), ring-necked ducks (*Aytha collaris*), redheads (*Aytha americana*), and lesser scaup (*Athya affinis*), were most commonly observed in the deeper ponds (A-3, A-4, B-5, C-2, and D-2). Species found more generally in shallow waters included blue-winged teal (*Anas discors*), green-winged teal (*Anas clypeata*), mallards (*Anas platyrhynchos*), cinnamon teal (*Anas cyanoptera*), and gadwall (*Anas strepta*). Puddle-ducks, primarily mallards, were also observed in pools, at seeps, and along creeks. Great blue herons (*Ardea herodias*) were observed on impoundment mudflats, and in ditches, short marshland, and wet meadows.

The most abundant year-round waterfowl at the Site during 1998 were mallards, with 370 observations during multi-species census surveys (Table 3-7). The mean annual sitewide relative abundance of mallards was 0.0781 o/m. The relative abundance of most other waterfowl and shore bird species varied seasonally. Aside from the abundant mallards, ring-necked ducks (0.039 o/m), American coots (*Fulica americana*) (0.031 o/m), Green-winged teal (0.024 o/m) and Lesser scaup (0.024 o/m) were the most common spring species. American coots (0.079 o/m), blue-winged teal (0.044 o/m), and pied-billed grebes (*Podilymbus podiceps*) (0.00.029 o/m) were the most abundant summer species. In fall, the most common species were buffleheads (0.034 o/m), American coots (0.029 o/m), and pied-billed grebes (0.018 o/m). The fall records were a departure from 1997, when the most common species were winter-migrant divers. The mild fall and winter weather may have encouraged the more common summer species to remain in the area longer. The most abundant species in winter, as in 1997, was the redhead (relative abundance = 0.015 o/m).

Several waterfowl species raised young at the Site during 1998. Brood counts and other observations confirmed nesting by pied-billed grebes, American coots, mallards, and blue-winged teal.

The species richness of waterfowl indicates that waters at the Site are of sufficient quality to attract large numbers of waterfowl, including several species that nest at the Site yearly. Species richness ranged from a high of 19 species in spring to a low of 10 during winter. Ninteen species were recorded as resident during the breeding season. A number of the waterfowl species stop over during migration because of the diverse aquatic communities in the ponds and, to a lesser degree, the creeks on the Site. Figure 3-8 shows a comparison of species numbers observed since 1993. A significant decline in the species richness or numbers of waterfowl could be an early warning of declining water quality at the Site.

3.1.5 Raptors (Sitewide and Multi-Species Surveys)

Raptors observed at the Site include all those normally associated with the range and habitats of this area of Colorado (Andrews and Righter 1992). One new raptor species, the barn owl (*Tyto alba*), was recorded in 1998. Raptor species using the Site varied between the spring/summer and fall/winter seasons, with great horned owls (*Bubo virginiana*), red-tailed hawks (*Buteo jamaicensis*) and American kestrels (*Falco sparverius*) remaining as year-round residents. Swainson's hawks (*Buteo swainsoni*), turkey vultures (*Cathartes aura*), and ferruginous hawks (*Buteo regalis*) were observed on the Site only in spring/summer. The northern harrier (*Circus cyaneus*) and golden eagle (*Aquila chrysaetos*) were recorded in summer, a season when they are rarely recorded at the Site. Rough-legged hawks (*Buteo lagopus*), northern harriers, bald eagles (*Haliaeetus leucocephalus*), and golden eagles were observed mostly in fall/winter. One peregrine falcon was recorded during a sitewide survey in summer, and a second (immature) individual was recorded as a fortuitous observation in the fall. These were most likely migrating individuals.

Among most raptors, demonstrated habitat preferences are divided between woody habitats (roosting and nesting areas) and grasslands and wetlands (foraging habitats) (see Tables 3-13 through 3-18). Falcon species were observed most frequently where their preferred prey (largely songbirds) was concentrated, commonly in riparian woodlands and shrublands. Being nocturnal, great horned and short-eared owls (*Asio flammeus*) normally were recorded in roosting locations during daytime surveys (shrubland, woodland, and abandoned buildings). Buteos (the broad-winged hawks), including roughlegged, red-tailed, and Swainson's hawks, were most often observed either roosting or nesting in riparian woodland, or soaring over marsh and grasslands where their prey is most abundant.

Red-tailed hawks, Swainson's hawks, great horned owls, and American kestrels nested at the Site in 1998. Figure 3-9 shows the locations of raptor nesting areas that have been active since 1991.

Recorded area use varied somewhat by season, but raptor observations were generally well dispersed across the Site during all seasons. Except within nesting territories, no particular concentration of activity was noted for any given species. Table 3-13 summarizes seasonal area use by raptors.

Relative abundance of raptors was variable by season (Tables 3-14 through 3-18), but the most abundant species year round was the great horned owl, with a mean annual relative abundance of 0.0036 o/m. The American kestrel is also a year-round resident, with a 1998 mean relative abundance of 0.0011 o/m. The red-tailed hawk's spring relative abundance was 0.005 o/m, and its sitewide annual relative abundance was 0.0006 o/m. Swainson's hawks showed an unusually high relative abundance (0.0021 o/m), probably because a nest site is within an established multi-species survey transect.

The continued presence of nesting raptors at the Site in 1998 indicates that habitat quality and protection from disturbances have contributed to making the Site a desirable location for raptors to reproduce. The normal seasonal species assemblages of raptors were observed at the Site, indicating that the habitat still provides the essential seasonal requirements for these species. Numbers and species richness remained similar to previous years, indicating that the Site probably supports the optimum population of these territorial species. Figure 3-10 shows a comparison of species numbers observed since 1993.

3.1.6 Fish Sampling

Fish were collected in each major stream across the Site during May 1998. The purpose of this sampling effort was to determine whether previously recorded fish species (DOE 1992) were still present at the Site, and to document any new species that might be present. Except for introduced species (e.g., largemouth bass), fish species that have been recorded at the Site are small stream fishes that are adapted to narrow, intermittent stream and pool systems. Sampling was timed to avoid spring floods to allow sampling more normal stream conditions.

The Site is dissected by four major stream drainages—Smart Ditch, Woman Creek, Walnut Creek, and Rock Creek—all flowing generally west to east across the property. These are headwaters streams that vary from ephemeral to intermittent, limiting the complexity of aquatic communities that have developed. Streams on the Site vary in width from a few inches (spring-fed flows) to five or six feet in downstream channels during spring runoff. These wide channels are often dry by summer. Upper headwaters, closer to the spring and seep discharge areas, may flow at a few gallons per minute all year, keeping small pools filled. Lower stream channels can be described as intermittent, with semi-permanent pools and channel subirrigation during the drier months. None of the streams on the Site maintains a permanent connection via constant flow of water to lower reaches in offsite areas.

Minnow traps were set out in areas where stream flow was sufficient to cover the traps, and trapping was done for two consecutive days at each sample point (see Figure 3-11). Limited numbers of fish were captured. Fathead minnows (*Pimephales promelas*) were captured in all streams sampled. Additionally, stonerollers (*Campostoma anomalum*) and creek chubs (*Semotilus atromaculatus*) were captured in Woman Creek. Due to the size of the Antelope Spring/Apple Orchard Spring wetland complex that discharges to the Woman Creek drainage, a greater portion of upper Woman Creek has sustained water flows. The additional water in this stream may account for the greater species richness found there. Ponds were not sampled in 1998, so species that prefer still water were unlikely to be captured. Ponds are scheduled for sampling in 1999.

3.1.7 Herptiles (Reptiles and Amphibians)

3.1.7.1 Amphibian Vocalization Monitoring

As a taxonomic group, the frogs and toads at the Site are recorded only occasionally during normal wildlife monitoring. Because these species are small and inconspicuous, observations have mainly been of close-by individuals or as random fortuitous observations. Although this approach has provided presence/absence records for these species, trends cannot be tracked. Because their semi-aquatic nature makes them sensitive to impacts, better data on these species could provide additional information for monitoring ecosystem health and stress, and for detecting potential contamination (Blaustein 1995). There is also general concern about amphibians as a group because of global population declines. To address this data gap, and to start gathering trend data on amphibians, an experimental vocalization monitoring effort was initiated in 1998. Monitoring was conducted on April 23, June 15, and July 13, 1998. Surveys began at dusk, usually about 8:30 p.m., and finished about midnight.

Methodologies that use vocalizations as a method of determining population trends for frog and toad species were adapted for use at the Site (Mossman and Hine 1984, 1985; Mossman et al. 1998; NBS 1997). Three species of frogs were recorded during the vocalization surveys during 1998: the boreal chorus frog (*Pseudacris triseriatus*), the northern leopard frog (*Rana pipiens*), and the bullfrog (*Rana catesbiana*). Figure 3-12 shows the sites at which each of the species was recorded during the surveys. The most commonly heard species was the boreal chorus frog, which occurred at 82 percent of the sites during the first survey period. The northern leopard frog was heard at only one site (6 percent) during the first survey. These species call in the early season, and were not recorded in June or July. Bullfrogs were heard on the two final surveys at one location each time (6 percent).

The vocalization indices are presented in Table 3-19. The boreal chorus frog was the only species that had an index of 2 or 3, indicating larger numbers of individuals present. All northern leopard frog and bullfrog vocalizations occurred with indices of 1, which indicated only a few individuals present.

The distribution of the species heard during the surveys on Site is shown in Figure 3-13. Boreal chorus frogs occurred with the greatest frequency and greater abundance (based on calling indices) in the north Buffer Zone. They were heard at all Rock Creek drainage sampling locations. Northern leopard frogs were heard only at the Lindsay Pond, and bullfrogs were heard only at Pond D-2. In addition to vocalizations, visual observations of northern leopard frogs were recorded during other ecological sampling in the Rock Creek drainage throughout the summer of 1998, and adult northern leopard frogs were observed along streams and in pools quite regularly. Bullfrogs were recorded in Ponds D-1 and D-2 during other surveys in 1998.

3.1.7.2 General Herptile Observations from Other Monitoring

Herptile species observed during 1998 included the boreal chorus frog, northern leopard frog, bullfrog, western painted turtle (*Chrysemys picta*), eastern short-horned lizard (*Phrynosoma douglassii brevirostra*), and the prairie rattlesnake (*Crotalus viridis*).

Observations of these species were sporadic and widely dispersed. Observations made during sitewide significant species surveys are summarized in Table 3-20, and observations from multi-species census surveys are summarized in Table 3-21. Habitat preference of herptiles varied by species. Table 3-21 presents habitat use as recorded during multi-species census surveys.

The presence of several sensitive reptile and amphibian species is an indicator of ecosystem health within the various habitats at the Site. Aside from call-count vocalization intensity categorizations for stationary breeding frogs and toads, obtaining a census of herptile species is difficult; therefore, estimates of populations cannot be made from the data presented here.

3.1.8 Special-Concern Species

Special-concern species are defined in Section 2.1.1.3. While the majority of the special-concern species that use or have potential to use the Site are animals, a few plant species also are included. It should be noted that these species are designated as special concern because of their rarity. Observations of rare species are inherently sporadic and infrequent; consequently, many of these species may not be observed at the Site every year. Lack of observations of special-concern species at the Site in any given year is not considered cause for alarm; however, no observations of a species for several years in a row would trigger a more intensive search, particularly if no regional decline in the species has been reported.

Aside from the Preble's meadow jumping mouse, which is resident at the Site, two threatened or endangered species use the Site seasonally. There are also several federal special-concern species and Colorado Species of Special Concern. Table 3-22 presents the Site's 1998 search list for special-concern species.

3.1.8.1 Threatened and Endangered Species

Listed threatened and endangered species observed at the Site during 1998 included the American peregrine falcon (*Falco peregrinus*) and the Preble's meadow jumping mouse. Peregrine falcons have nested in the Flatirons a few miles northwest of the Site for several years (EG&G 1995a). Observations of peregrine falcons included sightings from sitewide surveys and a fortuitous observation. Preble's mouse monitoring is reported below in Section 3.1.8.5.

These species are of concern at the Site because of their protected status under the ESA. Site activities must be planned such that no take (harassment or harm) of these species occurs during the time they are present within Site boundaries. DOE must enter Section 7 consultation under the Endangered Species Act when Site actions may affect these species.

3.1.8.2 Federal Special-Concern Species

Federal special-concern species observed during 1998 included the eastern short horned lizard, the loggerhead shrike (*Lanius ludovicianus*), and the western burrowing owl (*Athene cunicularia hypugea*).

3.1.8.3 Colorado Species of Special Concern

Colorado Species of Special Concern using the Site during 1998 included the northern leopard frog (*Rana pipiens*), the long-billed curlew (*Numenius americanus*), and the American white pelican (*Pelecanus erythrorhynchos*).

3.1.8.4 Watch-Listed Species

Watch-listed species observed at the Site during 1998 included such raptors as the the Swainson's hawk (*Buteo swainsoni*), the northern harrier (*Circus cyaneus*), the prairie falcon (*Falco mexicanus*), and the golden eagle (*Aquila chrysaetos*). Water birds included the bufflehead (*Bucephala albeola*) and the sora (*Porzana carolina*). Songbirds on the list of watch-listed species included the marsh wren (*Cistothorus palustris*), chestnut-collared longspur (*Calcarius ornatus*), chestnut-sided warbler (*Dendroica pensylvanica*) and the grasshopper sparrow (*Ammodramus savannarum*).

3.1.8.5 Preble's Meadow Jumping Mouse Monitoring

The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) was listed by the U.S. Fish and Wildlife Service as a threatened species in May 1998 (FR 1998). Because the conservation and protection of this species is an important issue at the Site, a special monitoring effort has been conducted for the past several years. Results from Preble's mouse monitoring help Site ecologists evaluate potential impacts from proposed remediation and Site closure projects, and allows the development of creative solutions to avoid unnecessary damage to Preble's mouse habitat during remediation.

In 1998, monitoring included efforts in two locations: Walnut Creek below the B-4 Dam, and the entire Rock Creek drainage. The purpose of sampling below the B-4 Dam was to determine whether that population of Preble's mice was still present. The major effort was pursued in the Rock Creek drainage. This study consisted of two parts: a movement

study using telemetry, and a population estimation study designed to provide a population estimate for the drainage.

3.1.8.6 B-4 Dam Population Presence/Absence

Monitoring in Walnut Creek attained the desired result of confirming the continued presence of the Preble's mouse population below the B-4 Dam in 1998. This monitoring effort was undertaken as a presence/absence, survey because no Preble's mice had been found in that population unit in 1997. The Preble's mouse monitoring effort in Rock Creek had several goals in addition to producing presence/absence data at trapping locations.

3.1.8.7 Population Estimates

Seventeen individuals were captured over both trapping sessions in the two creeks—five in Walnut Creek and 12 in Rock Creek. There were only three recaptures of PIT-tagged mice. Because of the limited data available from the low capture-recapture numbers, 1998 data were insufficient for the use of mark-recapture methods of estimating populations.

In using the mark-recapture method of population estimation, assumptions include: 1) that an adequate number of mice are recaptured within a specific time period, 2) that the individuals captured along any particular transect are resident to that specific transect, and 3) that no deaths or births occur during the trapping period. Trapping results did not meet assumption 1; that is, there were an insufficient number of captures. In addition, telemetry showed that individual mice were not restricted to any one transect. Indeed, some individuals traveled widely. After being captured and fitted with collars, some mice avoided recapture, but were radio-tracked living among the set traps up to a week at a time without being recaptured. Uncollared Preble's mice were also observed occasionally within active trapping areas when none were trapped within those specific transects. One must also consider the phenomenon of "trap shyness" associated with low trapping success, especially in an area such as the Site where trapping has been conducted for several years in succession. If animals were avoiding traps after initial capture, it could result in a false indication of a population decline.

Because population estimates for the Site may be an essential tool for long-term conservation of the Preble's mouse, an alternative method of population estimation was used. Using density estimates obtained from 1995–1996 trapping, combined with the total area of available habitat on the Site, a representation of the upper bounds of Preble's mouse numbers was calculated. This population estimate provides a probable range of numbers that may be supported, given ideal conditions. Upper-bound estimates are useful because they give an order-of-magnitude context to what the actual population numbers may be, given the highest quality habitat over a large stream reach. For example, Rock Creek, including all its tributaries, contains about 4.5 miles of linear stream channel. In Rock Creek, population estimates for primary habitat and all available

habitat (i.e., primary and secondary habitat) range between 200 and 862 Preble's mice in the entire drainage. The upper-limit calculation for the entire Site, based on all available habitat, is from 792 to 1,946 Preble's mice sitewide. Appendix B gives a detailed explanation of the primary and secondary habitat types, the average estimated densities, and the upper-bound population estimates.

3.1.8.8 Telemetry Results

After quality checks, and elimination of questionable vectors, 230 points were used to calculate the movement information presented here. These points were based on 195 points determined by radio telemetry bearings, 15 capture locations, and 20 visual observations that were located using a Global Positioning System (GPS). An uncertainty analysis was made using 11 points, derived from 11 different sets of bearings and 11 visual observation points. Based on this uncertainty analysis, point estimates should be viewed as accurate to ±23 m (75.5 ft).

Movement Patterns—Adult Preble's mice captured during the 1998 trapping were fitted with radio collars. Six male Preble's mice were radio tracked during the first telemetry session (19 June to 6 August), and three Preble's mice (2 males and 1 female) were tracked during the second session (1 September to 5 October). Other individuals (three females) were tracked only a few days to a week, for various reasons.

The average distance a mouse traveled between observation intervals (approximately 24 hours) was 142 m (464ft) (assuming linear travel). The maximum distance traveled by a single individual between observation intervals was 1,025 m (3,363 ft or 0.64 mi). Using the most widely separated points recorded for each individual on a single stream reach, average and maximum distances of travel were calculated. Over the length of the study, the average distance of travel was 715 m (2,346 ft or 0.44 mi); the maximum was 1,610 m (5,282 ft or 1.0 mi). These measurements were made by using the Geographical Information System (GIS) mapping utilities to calculate the distance along the stream reach. Figure 3-14 shows telemetry location points recorded for each of eight mice. In one case, although the individual (summer mouse #6) remained largely within a single stream reach, ranging an impressive 1,610 m (1.0 mi) between extremes, that mouse was also recorded in an entirely different branch of Rock Creek. Although the route of that outlying excursion is unknown, the actual distance traveled by that individual during the study is considerably longer than 1,610 m (1.0 mi). Considering that Preble's mice generally follow the meanders of the stream channels, these distances may be conservative estimates for actual distance traveled.

The maximum perpendicular distance an individual was observed away from the main Rock Creek stream channel was 245 m (804 ft or 0.15 mi). This observation, as well as all other mouse locations that were a relatively long distance from the stream, was within the Rock Creek basin and within the bounds of the seep wetlands. No Preble's mice were observed traveling to xeric tallgrass prairie or other dry areas at or near the top of the pediment.

Daytime nesting sites and likely hibernation locations were located through the use of radio telemetry. Daytime nests (2) were found along a main stream channel, close to the creek, and in seep shrublands a great distance away from the main stream channel. The farthest perpendicular distance a mouse was observed from the main stream (245 m) was in association with a daytime nest. Probable hibernation sites (2) were found along the stream and in the seep shrublands 155 m (580 ft) away from the main stream channel.

Home Range—Estimated home ranges were based on the movements of five adult males that were tracked during the summer monitoring session. The resulting home ranges, shown in Figure 3-15, vary from 4 to 31 ha (9.9 to 76.6 acres), illustrating the variability among individuals. These values for Preble's mice are much greater than the home range of a typical deer mouse (*Peromyscus maniculatus*). Studies in other western states (Bowers and Smith 1979) found that deer mouse home ranges vary from 0.08 to 0.12 ha (0.20 to 0.30 acres). It is noteworthy that the home ranges of some male Preble's mice tend to overlap considerably with larger home ranges that almost completely contain smaller ranges. Although the ranges indicate much spatial overlap, the temporal overlap (two males in the same locale at the same time) was much smaller.

The telemetry observations indicate a wide range of habitat use, all within the Rock Creek seep wetlands and riparian woodland complex. Within this drainage, mice appear to travel widely. The travel distances observed by using a few collared Preble's mice illustrate how important relatively long stream segments may be to Preble's mouse populations. These distances may be extreme examples, or may be typical only for seep-fed stream systems. However, it does speak to the need to consider all contiguous stream reaches with appropriate habitat as essential for some Preble's mouse populations.

Area Use—Telemetry observations were also useful in interpreting trapping results. At first glance, the number of mice recorded in Rock Creek in 1998, during a relatively large trapping effort, appears low. One might expect to find nearly 200 mice, based on the Site's density estimates for good habitat. However, only 12 individuals were captured in Rock Creek in 1998. Movement of collared mice during the first session of trapping indicated that mice were present within the trapping transects but nearly always avoided capture once collared. With this in mind, any population estimate using trapping results should consider a "trap shyness model" when estimating Preble's mice populations. Mark-recapture estimation methods, in general, depend on numerous recaptures and a relatively sedentary population. The application of these methods to the wide-ranging and rare Preble's mouse will be difficult, if not impossible, in any given year. To date, monitoring can only rely on the continued presence of Preble's mice to indicate continued occupation in any creek drainage.

3.2 Migratory Birds

Migratory birds are monitored using two methods: migratory bird transect surveys, and multi-species census surveys. Each method collects different combinations of data, and each provides specific types of information on species population trends and habitat use.

As of 1998, 191 species of birds have been recorded at the Site. Among all survey methods, 113 species of birds were recorded on the Site in 1998. Three new species were recorded: the barn owl (*Tyto alba*), the black-billed cuckoo (*Coccyzus erythropthalmus*), and the western bluebird (*Sialia mexicana*). At present, 73 species of birds have been confirmed or are suspected of breeding at the Site. Confirmed breeding species are those species that have been observed building nests or tending eggs or young, or for which young, flightless nestlings have been observed. Suspected breeding species are those that have been observed carrying nesting material, food, or other such indicators of breeding activity without actual visual confirmation of the presence of a nest or young. Among the 102 species of neo-tropical migrants known to use the Site, 45 are confirmed or suspected breeders at the Site.

Relative abundance categories of all bird species using the Site since 1991 are shown in Table 3-23. This table is based on observed bird distribution by habitat during migratory bird surveys, multi-species census surveys, sitewide surveys, project-specific surveys, and fortuitous observations. This summary table shows a running tally of species recorded at the Site since 1991, and presents relative abundance categories (e.g., abundant, common, rare, etc.) in appropriate habitats for each species. The table does not estimate total population numbers of each species inhabiting the Site, but is intended as a cumulative summary of birds observed by all methods at the Site. Note that some species are very habitat specific, while others are ubiquitous.

Evaluation of habitat use by birds, as indicated by data from cumulative combined records for all observation methods since 1991, yields different total species numbers for the different habitats than the species richness data from bird surveys alone (discussed below in Section 3.2.2). Based on all combined data, there are 191 bird species that use the Site at some time during the year. Bird species richness in the major habitats at the Site is 93 species in grasslands, 87 species in tall upland shrubland, 80 species in riparian shrubland, 112 species in riparian woodland complex, 117 species in wetlands, and 51 species in disturbed habitats (Table 3-23). Seasonal use also varies, with the greatest species richness observed during spring and fall (140 and 118, respectively), and lowest richness in winter (56).

3.2.1 Bird Relative Abundance from Multi-Species Census Surveys

Assessment of relative abundance is a means of determining relative numbers of species within various habitats and sitewide. The 1998 multi-species survey results for migratory birds (exclusive of waterfowl and raptors, which were discussed in previous sections) were analyzed for relative abundance of species within specified habitats by season, sitewide by season, and sitewide for the year. Comparisons made in the following sections are based on relative abundance of species within habitats and sitewide. Table 3-24 shows seasonal and annual summaries of bird relative abundance sitewide. Comparisons of results based on numbers observed per unit time in a given habitat are presented in Appendix B.

3.2.1.1 Year-Round Sitewide Relative Abundance

As shown in Table 3-24, European starlings (*Sturnus vulgaris*) replaced house finches as the most abundant bird species across the Site year-round (0.1684 observations per minute of observation [o/m] in 1998, compared to 0.2109 o/m of house finches [*Carpodacus mexicanus*] in 1997). Such abundance of this Eurasian invader is a cause for concern, because this species affects many of the neotropical migrants that are commonly known to be declining in numbers across their entire range. The most abundant native migratory bird species was the red-winged blackbird, at 0.1489 o/m (compared to 0.1707 o/m in 1997). House finches dropped to third most abundant year-round (0.1359 o/m in 1998, compared to 0.2109 o/m in 1997). Several other species are also quite abundant at the Site, largely on a seasonal basis. These species include the western meadowlark (*Sturnella neglecta*) (0.1034 o/m in 1998), vesper sparrow (*Pooecetes gramineus*) (0.0928 o/m, a slight increase from the 1997 0.0898 o/m), song sparrow (*Melospiza melodia*) (0.0437 o/m), and barn swallow (*Hirundo rustica*) at 0.0399 o/m. Cliff swallows (*Hirundo pyrrhonata*) dropped from 0.1125 o/m in 1997 to 0.0143 o/m in 1998. Note that these trends are not the same shown for some of these species using different data-gathering methods discussed in the next section.

3.2.1.2 Spring Relative Abundance

Sitewide species richness was greatest (47 species), and the greatest diversity of habitats are used in spring (Tables 3-25 and 3-26). A number of the migratory species became abundant or common as the season advanced. One surprise was the reappearance of the savannah sparrow (*Passerculus sandwichensis*), a species that had not been recorded at the Site since 1991. This species is apparently casual to accidental in the area. The most abundant species were the western meadowlark (0.213 o/m in 1998, compared to 0.151 o/m in 1997) and the red-winged blackbird (*Agelaius phoeniceus*) (0.190 o/m in 1998, compared to 0.172 o/m in 1997). European starlings increased in relative abundance from 0.078 o/m in 1997 to 0.180 0/m in 1998, and house finches also increased (0.087 o/m in 1998 from 0.076 o/m in 1997). These species were followed in abundance by the vesper sparrow (0.072 o/m), with greater relative abundance than in 1997; song sparrow (0.062 o/m), which remained the same as 1997; and American robin (0.049 o/m). A large flock of mountain bluebirds (*Sialia currucoides*) accounted for an enormous increase in relative abundance from 1997 (0.008 o/m) to 1998 (0.048 o/m). Cliff swallows (*Hirundo pyrrhonota*)—with a relative abundance of 0.014 o/m in 1998, compared to 0.264 o/m in 1997—and barn swallows (*Hirundo rustica*) dropped from 0.053 o/m in 1997 to 0.010 in 1998. For habitat use and species abundance of other species in spring 1998, refer to Tables 3-25 and 3-26.

Habitat preferences for the various species corresponded to the niches filled by each. American goldfinches and house finches were most commonly found in riparian woodland/shrubland (49 percent and 69 percent, respectively). Red-winged blackbirds typically preferred marshlands (72 percent) and riparian areas (15 percent). Northern orioles (*Icterus glabula*) used riparian woodland heavily (87 percent). Song sparrows

divided their time among riparian woodland/shrubland (34 percent), marshland (27 percent), and tall upland shrubland (39 percent). Black-billed magpies spent less time in riparian woodland/shrubland (40 percent) than tall upland shrubland (55 percent), which was nearly the reverse from habitat use in spring 1997. Vesper sparrows and grasshopper sparrows (*Ammodramus savannarum*) were observed more often in grasslands (64 and 67 percent respectively) than in other habitats. Western meadowlarks divided their time largely between grasslands (37 percent) and riparian woodland (28 percent), probably because of the abundant perch-points offered by woodlands. European starlings, as in other seasons, preferred riparian woodlands (87 percent), and mourning doves were also most recorded in the woody vegetation of riparian communities (79 percent).

3.2.1.3 Summer Relative Abundance

Summer showed the second greatest species richness of the multi-species surveys, with 44 species recorded (Tables 3-27 and 3-28). Species with the greatest recorded abundance were the European starling (0.383 o/m in 1998—a large increase from 0.163 o/m in 1997), red-winged blackbird (0.323 o/m), house finch (0.283 o/m), vesper sparrow (0.155 o/m), barn swallow (0.114 o/m, an increase from 0.106 in 1997), western meadowlark (0.113 o/m, a decrease from 0.203 o/m in 1997), and American goldfinch (which decreased from 0.126 o/m in 1997 to 0.076 in 1998). Cliff swallow observations decreased markedly, from 0.123 o/m in 1997 to 0.038 in 1998. Other species of note were the grasshopper sparrow at 0.074 o/m (nearly double that of 1997), and song sparrow at 0.072 o/m, somewhat increased from 1997. Most other species also showed variance from the relative abundances recorded in 1997. For habitat use and species abundance of other species during summer 1998, refer to Tables 3-27 and 3-28.

Over 50 percent of the red-winged blackbirds were recorded in tall marsh. Grasshopper sparrows preferred xeric mixed grassland in 29 percent of observations, with habitats of similar vegetation structure being favored as well (34 percent of observations). Finches were most commonly observed in riparian woodland/shrubland (house finch, 65 percent; lesser goldfinch, 67 percent, and American goldfinch, 69 percent). Tall upland shrubland was the second most favored habitat for this group. Swallows were recorded around water or along riparian woodland/shrubland habitats the majority of the time in summer. Song sparrows spent the majority of their time in woody habitat as well, with 34 percent of observations in riparian woodland and 27 percent in tall upland shrubland. Rufous-sided towhees (*Pipilo erythrophthalmus*) were observed almost exclusively in tall upland shrubland (98 percent). As in other seasons, black-billed magpies divided most of their time between riparian woodland/shrubland (56 percent) and tall upland shrubland (14 percent). Vesper sparrows (53 percent) and western meadowlarks (32 percent) favored grasslands, although western meadowlarks used riparian habitat heavily as well (26 percent). As in other seasons, European starlings were most frequently observed in riparian woodland (89 percent). During the summer, American robins continued to show their affinity to woody habitats (48 percent riparian and 22 percent tall upland shrubland).

3.2.1.4 Fall Relative Abundance

Fall of 1998 found 36 species recorded during the multi-species surveys (Tables 3-29 and 3-30). The most abundant species changed somewhat; house finches (0.134 o/m) and vesper sparrows (0.126 o/m) were followed by white-crowned sparrows (*Zonotrichia leucophrys*) (0.081 o/m), western meadowlarks (0.061 o/m), American robins (0.048 o/m), and European starlings (0.047 o/m). For habitat use and species abundance of other species during fall 1998, refer to Tables 3-29 and 3-30.

Habitat preferences remained similar to other seasons, with house finches, black-billed magpies, and song sparrows preferring woody habitats (32 percent, 50 percent, and 33 percent, respectively). Vesper sparrows were divided among grasslands (67 percent), wetlands (11 percent), and woody habitats (27 percent). Western meadowlarks were observed less often in woody habitats (26 percent) than grasslands (58 percent), the reverse of records in 1997. The affinity of European starlings for riparian woodland remained consistent (63 percent).

3.2.1.5 Winter Relative Abundance

Fourteen bird species were observed sitewide during winter multi-species surveys. Some are winter residents, some are early migrants, and the remainder are year-round residents. Most species observed during winter were seen predominantly in woodlands and shrublands. The exceptions were species that are normally associated with grasslands or wetlands. Approximately 75 percent of the horned lark (*Eremophila alpestris*) and western meadowlark observations were in grasslands. The most common winter species during 1998 was the black-billed magpie (relative abundance = 0.069 o/m). Although this species was observed in a variety of habitats, the great majority of observations were in woody habitats (riparian woodland 36 percent, and tall upland shrubland 48 percent). Another species found predominantly in woody habitats was the American tree sparrow (*Spizella arborea*) (relative abundance = 0.053 o/m), of which 90 percent of observations were in these habitats. Northern flickers (*Colaptes auratus*) (0.024 o/m) preferred riparian woodland/shrubland (75 percent). Black-capped chickadees (*Parus atricapillus*) were less abundant in 1998 (0.017 o/m) than in 1997 (0.030 o/m), and their habitat use changed to a more even division between riparian woodland/shrubland (41 percent) and tall upland shrubland (59 percent), compared to 85 percent of observations in riparian habitat in 1997. Song sparrow (*Melospiza melodia*) sitewide relative abundance of 0.008 o/m in 1998 remained comparable to 1997 at 0.007 o/m; habitat use was similar. American robins were less frequently observed during winter 1998 (0.002) than winter 1997 (0.040 o/m), and they preferred tall upland shrubland (89 percent). For habitat use and species abundance of other species during winter 1998, refer to Tables 3-31 and 3-32.

3.2.2 Migratory Bird Survey Summaries

The goal of monitoring the bird communities on the Site is to detect change or observe trends in the number of birds present or in the bird assemblages of certain habitats or

seasons. Several years of migratory bird survey data, from surveys performed along 20 permanent transects at the Site, were evaluated. During these surveys, data on birds are collected along the established belt transect (other species are not recorded). Data sets were analyzed for trends in species richness (number of species) and bird diversity by habitat during each season and annually, and by season regardless of habitat. Bird densities (individuals per square kilometer) were calculated for each of seven major habitats and by season regardless of habitat. Jaccard's similarity coefficient was calculated for bird assemblages during June (breeding season) and all summer months. Data collected during 1998 were compared to seven years of previously reported data (DOE 1992; EG&G 1994, 1995b; RMRS 1996; K-H 1998c) to examine trends in these parameters. Discussions below include analyses of data from breeding season, summer and winter seasons, and spring and fall migration seasons.

During 1998, 88 bird species were recorded on migratory bird surveys alone. Fifty-one of these species (58 percent) were neo-tropical migrants. This large percentage of neo-tropical migrants using the Site demonstrates the importance of the habitats provided by the Site to this sensitive group of bird species.

3.2.2.1 Bird Community Measures: Diversity, Species Richness, Similarity

The Simpson's diversity index (D′) is used as a means of comparing among habitats and from year to year. The index takes into account both the number of species present and the relative abundance of those species. Generally speaking, more species in greater abundance will raise the value of the index. However, the index emphasizes the even distribution of abundance across species, so observations of bird species that forage in flocks in the same habitat with solitary species will have the effect of lowering the index for that habitat. No diversity index should be treated as a value judgment. Higher diversity is not always "better" (e.g., addition of a non-native species is not an improvement).

Diversity indices can also reflect the number of available niches in the different habitats (i.e., more niches may mean greater diversity). A woody habitat provides more niches within its three-dimensional, multi-strata environment than does a grassland. Grasslands with greater vegetative species diversity (e.g., native xeric grassland) provide more niche opportunities than the near monoculture of a reclaimed grassland. Therefore, the apparent correlation of species diversity to habitat type is expected, as discussed below.

Species Richness is the simple tallying of the bird species present within a particular habitat (e.g., mesic grasslands) or during a certain time interval (e.g., winter). Changes in species richness over time can reveal additions to or losses from bird assemblages and may drive changes in diversity indices. However, entire shifts in assemblages can be missed if different species are observed in similar numbers in the data sets. For this reason, it is also useful to compute a similarity index (Jaccard's coefficient) to detect a change in assemblage (or community) similarity from year to year.

All three of these measures are used to track changes in the dynamic bird communities on the Site. These measures were used in evaluating bird data from year to year, regardless of habitat, and within each of the seven major habitats present at the Site.

Bird Community Measures for the Entire Site—Species richness across the Site during 1994–1998, regardless of habitat and season, shows a slight increase (Figure 3-16). The years 1991 and 1993 were not included in this Site summary, because these data sets only include surveys from winter and June.

The sitewide diversity indices, as indicated by the Simpson Index, have remained at a steady state for the last five years (Figure 3-17). Within each year, there is far more variability among the different seasons and habitats, but in tracking diversity indices from year to year, variability is minimal. Species richness and bird diversity indices compared between years and from season to season, regardless of habitat, show little change.

Bird Community Measures in Habitats Within Seasons—Community measures of species richness and diversity indices vary across habitats within each season. Overall, richness and diversity indices show the variability normally associated with year-to-year responses to differing weather patterns. No significantly decreasing trends were noted over time across seasons within any of the seven major habitats (Table 3-33). Compared to prior years, species richness is greater in 1998 (Table 3-34), but is proceeded by three years of relatively lower richness.

Bird Community Measures for Breeding Birds in June—Over the past seven sample years (1991, 1993–1998) combined, the breeding season diversity indices for all habitats on the Site show a steady state (Table 3-33). Most habitats within the Site show a similar steady trend, with the exception of mesic grasslands, which show an upward trend ($D' = 0.76$ in 1991 to $D' = 0.91$ in 1998). Figure 3-18 shows June bird species diversity indices by habitat for all years.

The habitats that consistently show the highest diversity indices are the woody habitats, such as riparian woodlands, tall upland shrubland, and leadplant-dominated riparian shrubland (Figure 3-18). The grasslands generally show lower diversity indices, but have a very different assemblage of birds than do woody habitats. Marsh wetlands show the lowest diversity indices during the breeding season, in part because of the dominance of red-winged blackbirds in cattail marsh. Diversity among habitats is as expected, because woody habitats provide a greater diversity of niches than grassland or marshland.

Species richness across all habitats during the breeding season (Table 3-35) shows an upward trend over time (42 in 1991 to 54 in 1998). In addition to species richness, the similarity index helps with data analyses by indicating whether a drastic shift in the species of birds using the Site has occurred (e.g., a similarity index of less than 0.50). By using the Jaccard's similarity index, one can see that the bird assemblages do change slightly from year to year (Table 3-36). These changes are the result of a certain species being absent one year and present the next, while another species may be present one year and absent the next. For example, in Table 3-36, the June species assemblage on the

Site in 1997 was most similar to that same assemblage in 1995, and least similar to 1991. It is apparent that the sitewide assemblage of bird species in 1998 was akin in similarity to all other years, but was most similar to 1994 and 1996.

Breeding bird assemblages show the greatest diversity indices in riparian woodland and tall upland shrubland habitats (Table 3-33). These two habitats, along with wetlands, have the greatest annual species richness maxima and averages (as indicated by bird surveys) of all the habitats surveyed (Table 3-34). Riparian woodland, tall upland shrubland, xeric grasslands, and mesic grasslands all exhibit an upward trend in species richness during the breeding season, with woodlands showing the largest increase . Leadplant-dominated riparian shrubland, wetlands, and reclaimed grasslands remain steady (Table 3-34).

A number of species that had not been recorded in woodlands during previous bird surveys increased the 1998 species richness. These species were chipping sparrow (*Spizella passerina*), ferruginous hawk (*Buteo regalis*), gray catbird (*Dumetella carolinensis*), and great blue heron (*Ardea herodias*). Nearly every other species that had been observed in woodlands in prior years was also recorded there in 1998. Both these factors contributed to the large increase in species richness in 1998.

In contrast to the large increase in species richness, especially in woodlands, one woodland species, the white-crowned sparrow (*Zonotrichia leucophrys*) was not observed during the breeding season in any of the seven habitats. In fact, this species was not observed during bird surveys conducted over any of the summer months. However, the species was observed in shrublands and woodlands during the spring and fall migration. Because this species is migratory at the Site, its absence during the breeding season is not cause for alarm. The early onset of mild spring weather may have encouraged breeding pairs to seek their normal high-altitude breeding grounds earlier than in some years.

An important subgroup of birds that use the Site during the breeding season is the neotropical migrants. This group of birds is characterized by species that travel to Central and South America to overwinter and return to breed in North America. In past years, a declining trend in species richness for neotropical migratory birds has been noted. However, species richness increased somewhat in the 1998 breeding season, especially in woodlands; the latest trend is upward in woodlands and mesic grasslands and a steady state in the remaining habitats (Table 3-37). Increases in neotropical species richness and diversity indices may be an indication of the importance of Rocky Flats habitats to this subgroup. Neotropical migrants globally have been a subgroup of concern in recent years because of range-wide declines in these species. It is somewhat surprising to find increasing trends at the Site when neotropical species in other places show significant declines.

Recent studies in the Boulder Valley have demonstrated that only a modest level of industrial or urban development (5—10 percent of an area) can have significant negative impacts on bird utilization of a particular area (Bock 1999). The trend reversal at the Site may demonstrate the critical importance of these undeveloped lands to the conservation

of birds locally. This trend should be monitored.

3.2.2.2 Bird Densities

The bird densities discussed below are calculated from data collected during migratory bird surveys only. All densities are calculated as birds/square kilometer (km^2). The areas surveyed are belt transects of known area; therefore, these calculations are a direct correlation of numbers observed during the surveys.

Bird Densities Sitewide—Most bird species observed within 50 m of the survey transects demonstrate a steady-state density across the Site from year to year. However, there are a few exceptions. Over the last five years, the European starling (*Sturnus vulgaris*) density has increased more than any other species (Table 3-38). Other species that demonstrate an upward trend in densities are the American robin (*Turdus migratorius*), European starling, American goldfinch (*Carduelis tristis*), and grasshopper sparrow (*Ammodramus savannarum*). Brown-headed cowbirds (*Molothrus ater*), mountain bluebirds (*Sialia currucoides*), pine siskins (*Carduelis pinus*), common snipe (*Gallinago gallinago*), and barn swallows (*Hirundo rustica*) demonstrated slight increases over the last five years.

Birds showing a decline over time are red-winged blackbird (*Agelaius phoeniceus*), cliff swallow (*Hirundo pyrrhonota*), mourning dove (*Zenaida macroura*), song sparrow (*Melospiza melodia*), and Brewer's blackbird (*Euphagus cyanocephalus*).

Bird Densities in June (Breeding Season)—The overall bird density (all species combined) in June over the entire site shows a declining trend over time (bird surveys from 1991, 1993–1998, Figure 3-19, Table 3-39). However, during the last four years, this trend has leveled off, showing a steady state. Additionally, later in the summer (July-August), densities show an upward trend, perhaps indicating increasing breeding success from year to year.

Overall bird densities by habitat in the month of June for all years are compared in Table 3-39. Four habitats (wetlands, riparian woodlands, riparian shrubland, and reclaimed grasslands) show a slight decrease in density over time. The native grasslands (mesic and xeric grasslands) and tall upland shrublands show an upward trend in density.

Table 3-40 shows a summary of 21 species selected as representative of the Site. Combined densities for all birds have varied from 152.6 birds/km^2 in 1991 to 149.7 birds/km^2 in 1998, showing what is probably normal fluctuation. After one year of particularly high densities overall, densities have stabilized around 150 birds per km^2.

Individual species show some interesting trends. Species with the steepest upward trend are undesirable species: the European starling and the brown-headed cowbird (Table 3-40). The increasing numbers of these two species probably affect native species. The European starling increase may affect cavity-nesting birds because of nest

site competition and depredation of young. The brown-headed cowbird, a bird parasite, may affect the breeding success of native breeding birds. Cowbirds lay their eggs in active nests of other species, and the host species raise the foster young. Young cowbirds grow quickly and aggressively out-compete the host's own young for food. They also may push competing young and eggs out of the nest, destroying the host's brood, and dominating the offered food for themselves. However, these effects have not been seen in community measures. Increases in these undesirable species may be a result of increasing urbanization surrounding the Site.

Native species that show increasing trends include grasshopper sparrows, black-billed magpies, and rufous-sided towhees. These three species represent a wide range of habitats across the Site (grasshopper sparrows—grasslands, magpies and towhees—woody habitats). When bird survey data are analyzed, native species that show declining density trends include vesper sparrows (*Pooecetes gramineus*), Brewer's blackbirds, song sparrows, western meadowlarks (*Sturnella neglecta*), red-winged blackbirds, and house finches (*Carpodacus mexicanus*) (Table 3-40). It should be noted that trends from multi-species surveys do not necessarily reflect trends shown by bird surveys. All but two species, the song sparrow and the house finch, are neotropical migrants. The relatively large decrease in house finch density may be due to the great mobility of the species. Like other finches, house finches form large, highly mobile feeding flocks that may travel widely. Records of high densities may reflect the presence of feeding flocks, rather than somewhat lower densities actually indicating a decline.

Several species from each of the seven major habitat types (21 in all) were selected as representative of trends in bird densities (individuals per km^2) for analyses of these species groups over time (see Table 3-41). Species were selected based on their overall abundance in each habitat type and/or their uniqueness to a particular habitat (indicator species). Trends of undesirable species, specifically the European starling (an alien species that out-competes native cavity-nesting birds for nest locations) and the brown-headed cowbird (a parasitic species), are also included in appropriate habitats.

In reviewing the 21 selected species across all habitats on the Site, five species show at least a slight increasing trend over time. The European starling and the brown-headed cowbird (less desirable species), and the black-billed magpie and rufous-sided towhee, show substantial increases, especially over the 1997 and 1998 breeding seasons. Four species—house finch, mourning dove, red-winged blackbird, and vesper sparrow—show downward trends over time. (Multi-species census surveys do not reflect the declines shown in bird survey data.)

The species showing the steepest decline, the house finch, was recorded in 1991 as large flocks in extremely high densities observed in woodlands. These large numbers and the associated flocks have not been recorded during any other year. Additionally, red-winged blackbirds show a decreasing trend in wetlands over the last eight years. This species was also once observed in wetlands at extremely high densities. Because Site wetlands have not decreased in area, nor have they been disturbed by Site activities, this trend may reflect a regional condition. The Colorado Front Range Urban Corridor is one

of the fastest growing regions in the country, and habitat fragmentation and alteration is commonplace.

The red-winged blackbirds, song sparrows, common yellowthroats (*Geothlypis trichas*), and common snipe represent wetlands. The overall trend in abundance of these species in wetland areas is a steady state (Table 3-41), with the exception of the red-winged blackbird as indicated above.

The house finch, European starling, northern oriole, American goldfinch, yellow warbler, brown-headed cowbird, and blue grosbeak represent riparian woodland habitat. Overall density trends of this group are increasing or steady state (Table 3-41), again with one exception: the house finch shows a decline over time. Of special note, European starlings and brown-headed cowbirds, both undesirable species, show an increasing trend in riparian woodland areas. Native species in general show a steady-state trend in densities.

The vesper sparrow, mourning dove, European starling, northern oriole, and Brewer's blackbird represent leadplant-dominated riparian shrubland habitat. The overall trends of these selected species are declining (Table 3-41), with the exception of increasing European starling densities, especially over the last year.

Tall upland shrubland habitat is represented by song sparrows, rufous-sided towhees, brown-headed cowbirds, black-billed magpies, yellow-breasted chats, and black-capped chickadees (*Parus atricapillus*). The overall densities for these species are increasing in this habitat, although yellow-breasted chats and song sparrows show a steady state. One interesting note is the recent appearance of black-capped chickadees in this habitat. During the first two years, no chickadees were observed, but the species has since appeared, increased in abundance, and expanded into riparian woodland habitat. Once again, an undesirable species—the brown-headed cowbird—shows a steep upward trend in density.

The vesper sparrow, house finch, western meadowlark, western kingbird, and grasshopper sparrow represent mesic mixed grasslands. The densities of vesper sparrows and house finches are decreasing, whereas western kingbirds and western meadowlarks are steady. Grasshopper sparrow densities have increased slightly over the past six years.

The vesper sparrow, western meadowlark, and grasshopper sparrow represent xeric mixed grasslands. These selected native species all show increased density over time. Also, there is a general trend of grasshopper sparrows increasing in grassland habitats across the site. Vesper sparrows demonstrate an overall decreasing trend in grasslands across the site.

The western meadowlark, vesper sparrow, and grasshopper sparrow represent reclaimed grasslands. The overall trends for these selected species are decreasing. Vesper sparrows and western meadowlark densities are decreasing; grasshopper sparrows show a steady abundance in reclaimed grasslands.

Bird Densities During Migration Seasons—Densities of migrating birds are variable, and species use from year to year can be sporadic. Because of this variability, only the analyses of selected species are presented in this discussion. The species discussed below are special-concern species and undesirable species. It should be noted that all estimates of numbers of individuals over the five years analyzed should be used for comparison purposes only. These are not intended to be population estimates.

Special-concern species occur sporadically from year to year, spring to fall, and within different habitats. The grasshopper sparrow, a representative special-concern species, is a prairie species and, accordingly, was found most consistently in the mesic, reclaimed, and xeric grassland communities. These three grasslands cover 1,966 hectares (ha) (4,856 acres), about 75 percent of the Site. The Site is on the edge of the species' summer breeding range, which extends across the Great Plains to the Rocky Mountains. The grasshopper sparrow is present at nearly twice the densities in the spring than in the fall, with an average of 15.6 birds/km^2 (0.156 birds/ha) in spring over the five years (1994–1998).

Raptors, a group that includes several special-concern species, have shown much variability in both spring and fall, but typically, raptors are observed at higher densities in the spring than in the fall. Average spring densities of raptors as a group are 0.47 birds/km^2 (0.0047 birds/ha) in spring, and fall densities average 0.36 birds/km^2 (0.0036 birds/ha). Spring and fall raptor densities have shown decreasing trends in the past, but with the addition of 1998 data, trends in densities appear to be leveling off. Past decreasing trends probably reflect the reduced number of prairie dogs in the vicinity of the Site since 1994. With a reduced prey base, raptors often seek better hunting elsewhere. Prairie dogs are reappearing in the area and apparently increasing in numbers from year to year. Correspondingly, raptor densities are beginning to return to pre-1994 levels.

European starlings, considered a nuisance species, are found in all habitats on the Site. European starlings have increased steadily in numbers each spring, from a sitewide density of 8.3 birds/km^2 in 1994 to 16.5 birds/ km^2 in 1998. The most noticeable increase was in the riparian woodland habitat, from 37.8 bird/km^2 to 62.2 birds/km^2. Sitewide fall densities are highly variable, showing markedly higher densities in 1995 (15.7 birds/ km^2) than 1996 (6.8 birds/ km^2), which is attributable to a drop in starling density in the riparian wood and shrubland habitats. In 1998, starling densities (16.9 birds/ km^2) surpassed 1995 levels.

Bird Densities in Winter—Bird observations vary in the winter but are generally too sparse to yield valid density analyses. Songbirds may be observed in ones and twos along an entire transect, or may be observed in flocks of dozens or more. On the average, several transects a month during the winter will record no observations. While the variability may make statistical analyses difficult, this is the time that important observations of raptor species are often made. Some species are solely winter residents, leaving the Site to nest in more northern latitudes during the warmer

seasons. To raptors and other winter residents, the Site provides an important parcel of undeveloped land in which to overwinter.

FIGURE 3-1. TOTAL NUMBERS OF MULE DEER IN WINTER (1994-1998)

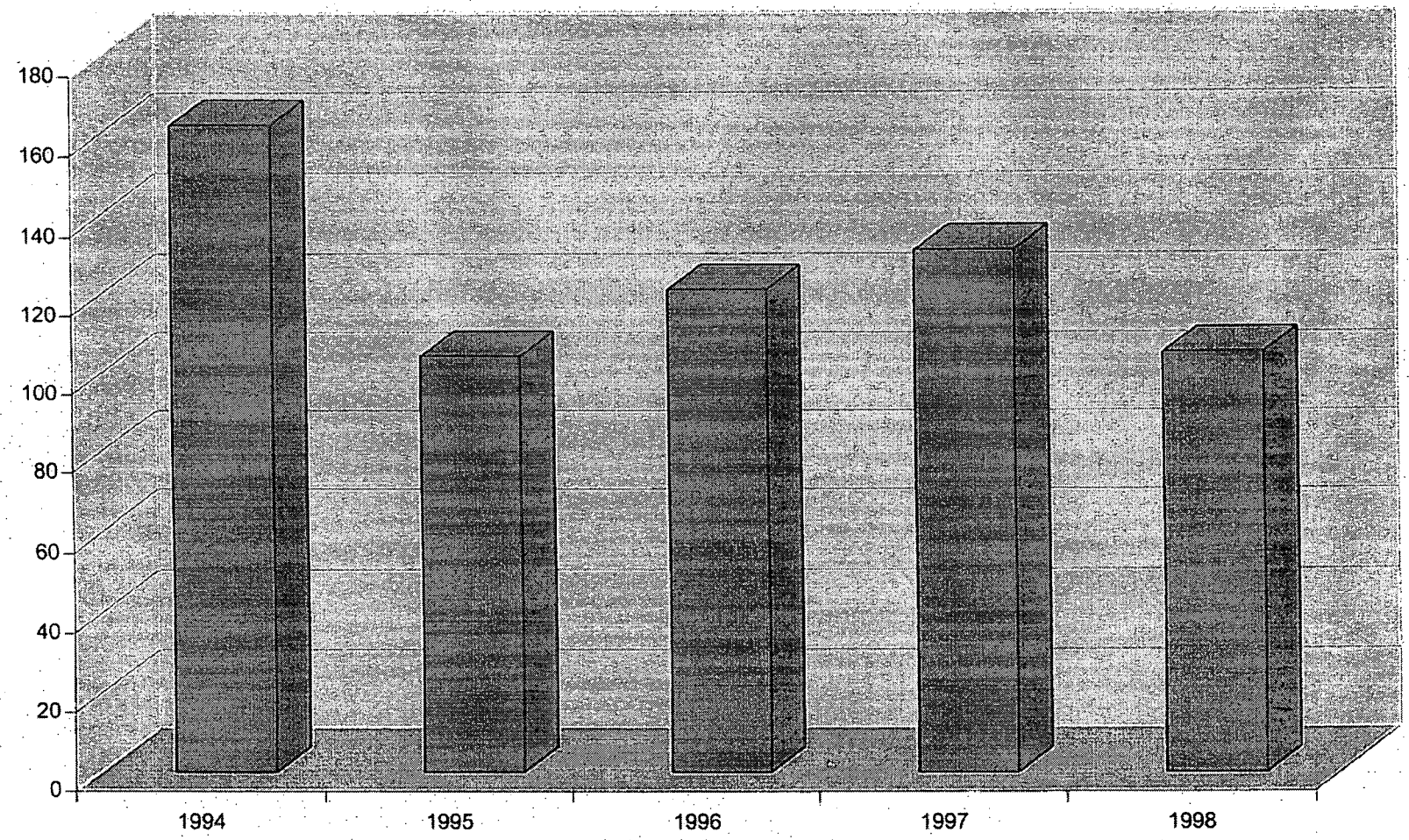
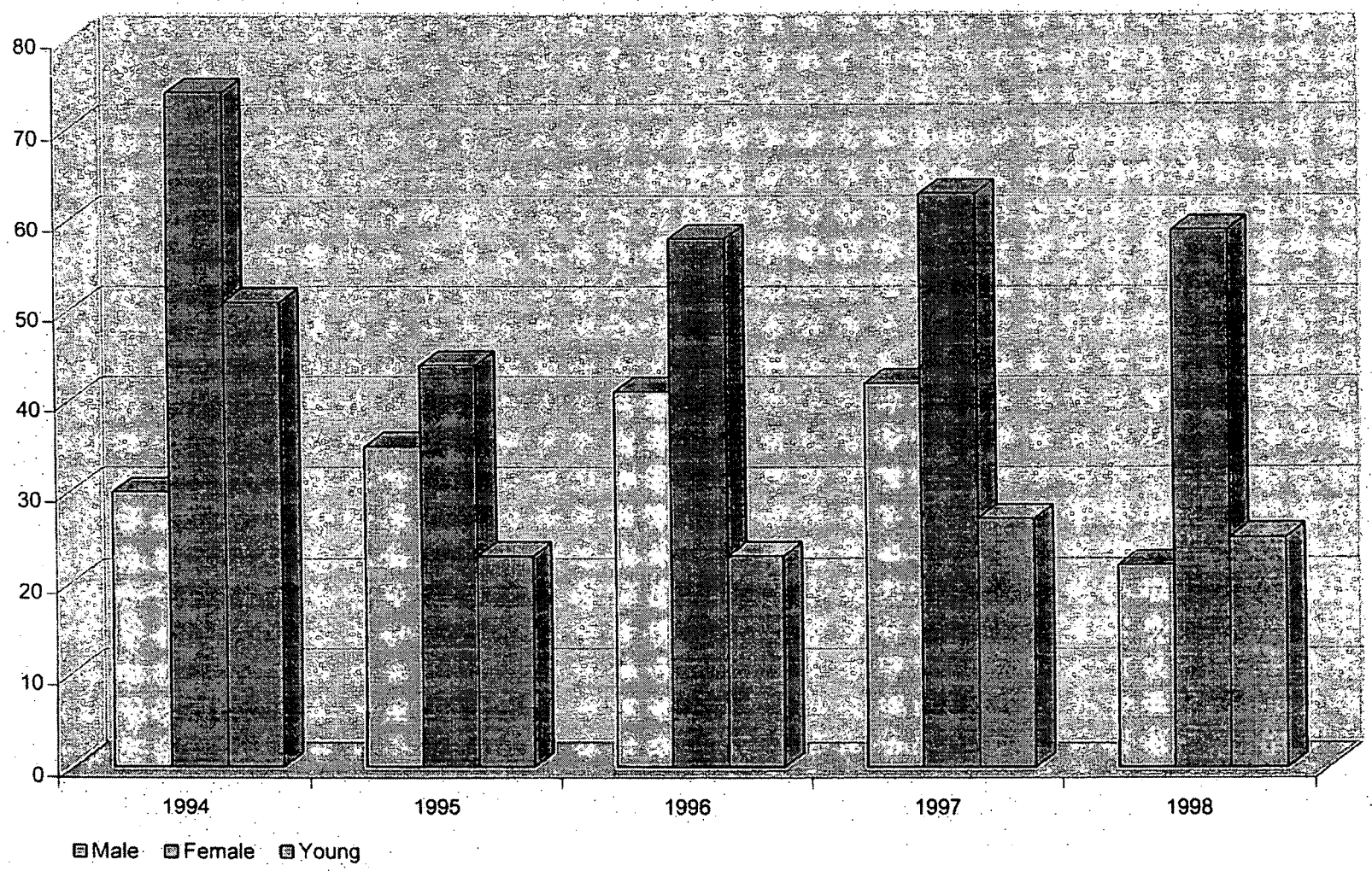
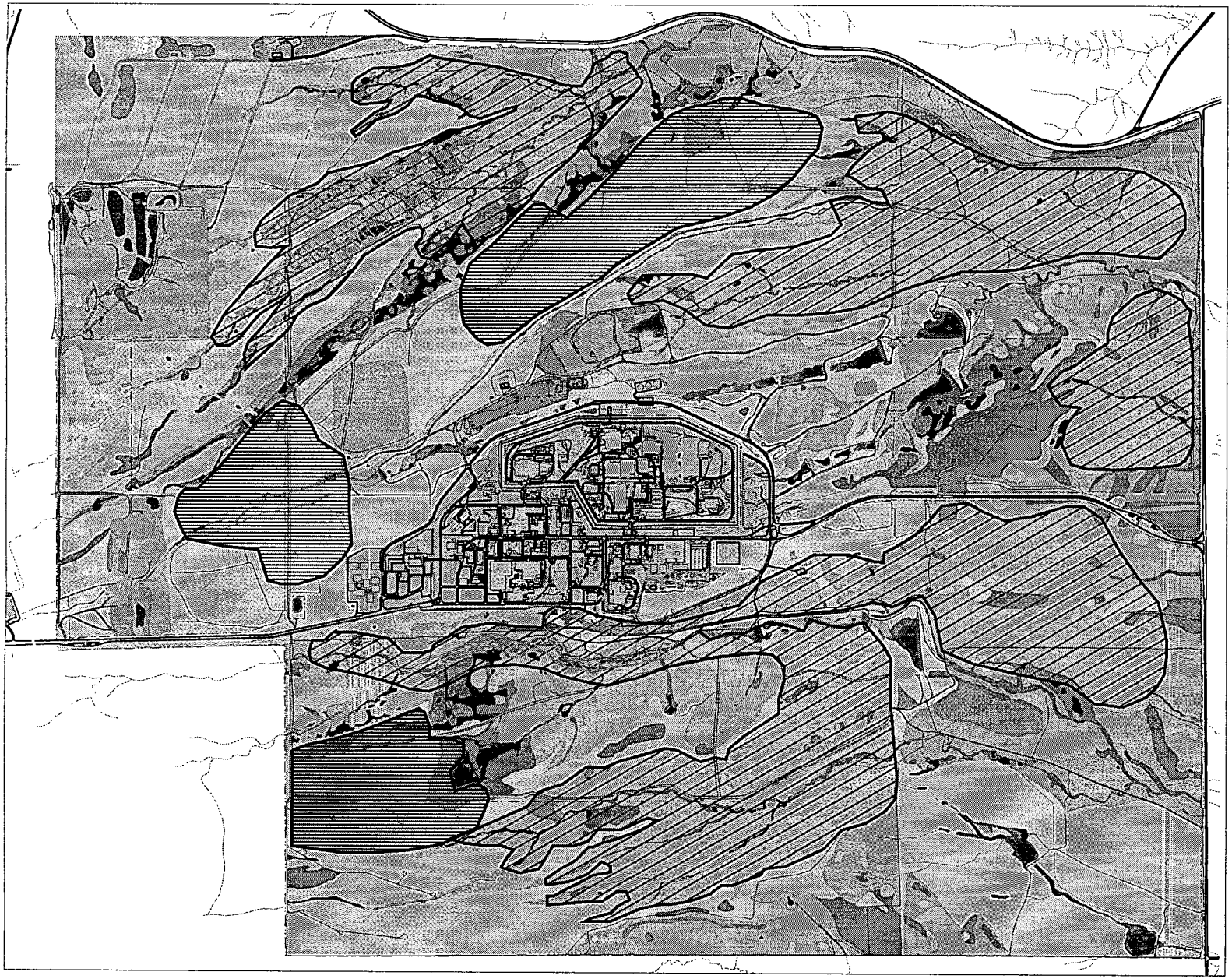


FIGURE 3-2. ANNUAL MULE DEER POPULATION COMPARISONS FROM WINTER COUNTS (1994-1998)





Mule deer use of the Rocky Flats Environmental Technology Site.

Figure 3-3.

MAP LEGEND

Mule deer use
- Essential Winter Range
- Fawning Area
- Frequent Breeding Season Use

Vegetation Types
- Annual Grass/Forb Community
- Disturbed and Developed Areas
- Leadplant Riparian Shrubland
- Mesic Mixed Grassland
- Mudflats
- Open Water
- Ponderosa Woodland
- Reclaimed Mixed Grassland
- Riparian Woodland
- Riprap, Rock, and Gravel Piles
- Savannah Shrubland
- Short Grassland
- Short Marsh
- Short Upland Shrubland
- Tall Marsh
- Tall Upland Shrubland
- Tree Plantings
- Wet Meadow/Marsh Ecotone
- Willow Riparian Shrubland
- Xeric Needle and Thread Grass Prairie
- Xeric Tallgrass Prairie

Standard Map Features
- Streams
- Fences
- Dirt roads
- Paved roads
- Buildings

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Vegetation types and wildlife data provided by Exponent.

N

1:21553

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mm/99-98 Deer Tabloid

April 27, 1999

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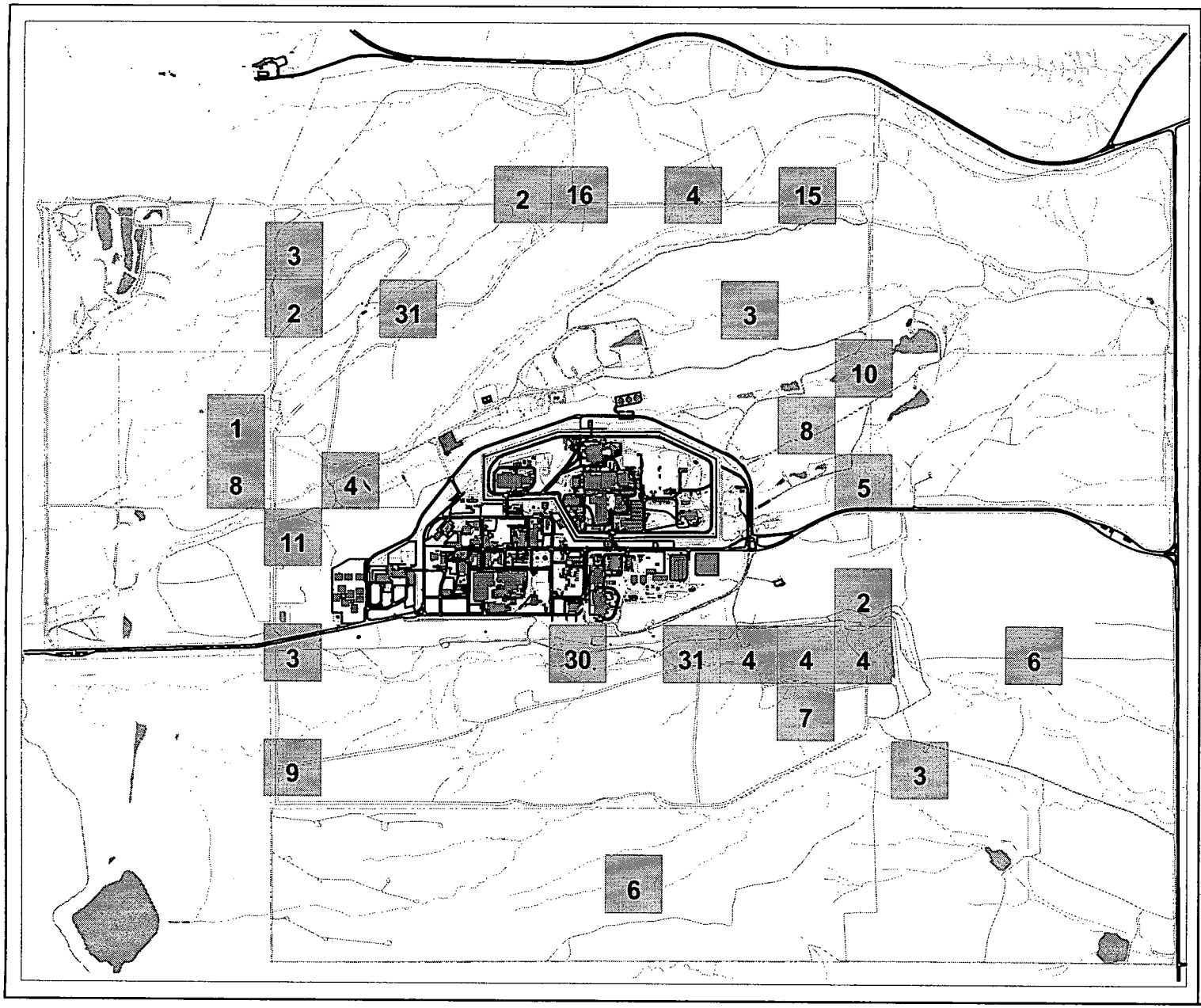

Mule deer
area use in spring.

Figure 3-4.

MAP LEGEND

Rocky Flats grid cell with mule deer occurence. Number indicates total individuals.

Standard Map Features

- Dirt roads
- Paved Roads
- Streams
- Fences
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

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State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-Mule Deer Spring

April 28, 1999

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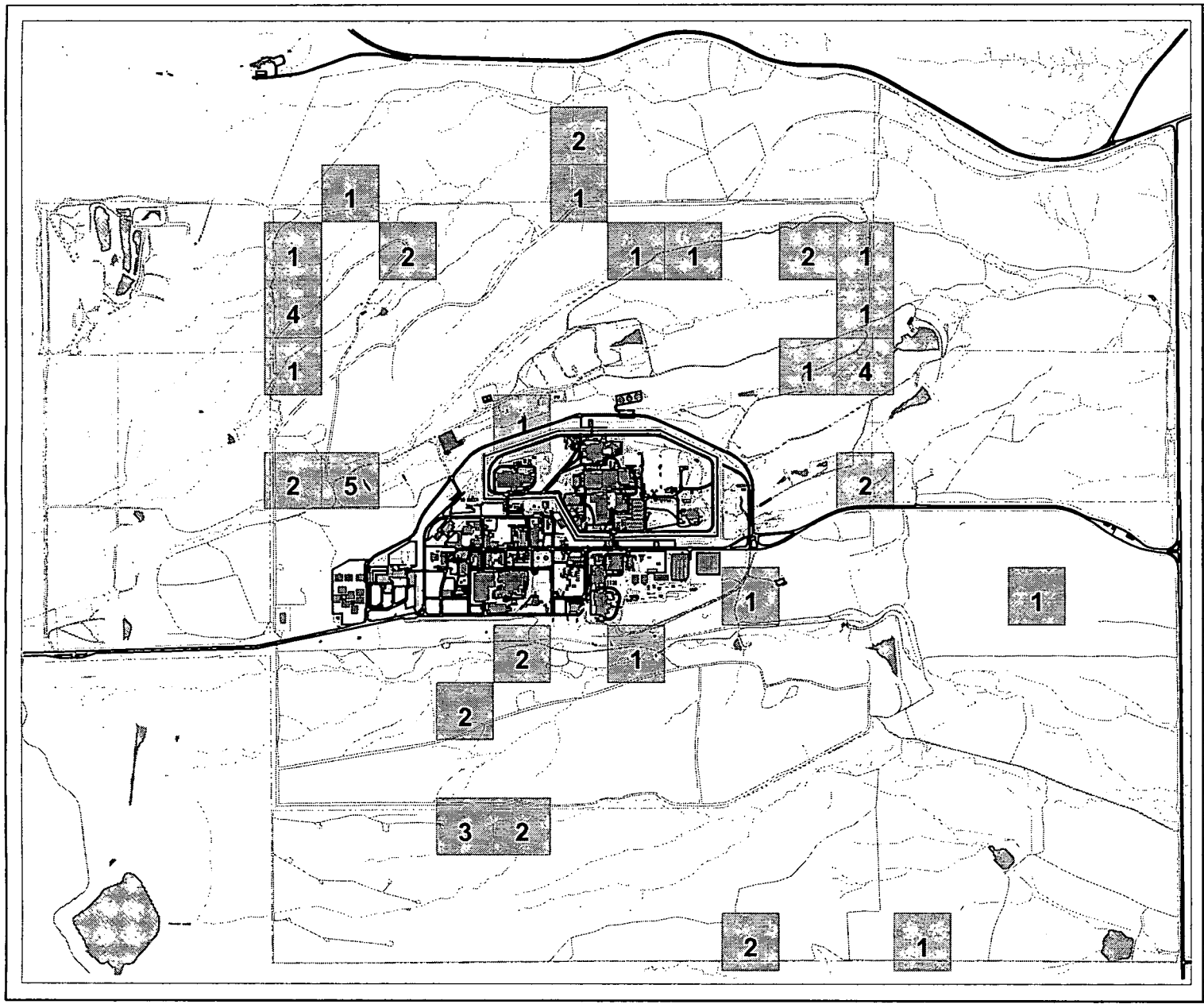

Mule deer
area use in summer.

Figure 3-5.

MAP LEGEND

Rocky Flats grid cell with mule deer occurence. Number indicates total individuals.

Standard Map Features
- Dirt roads
- Paved Roads
- Streams
- Fences
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

N

1:32000

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-Mule Deer Summer April 28, 1999

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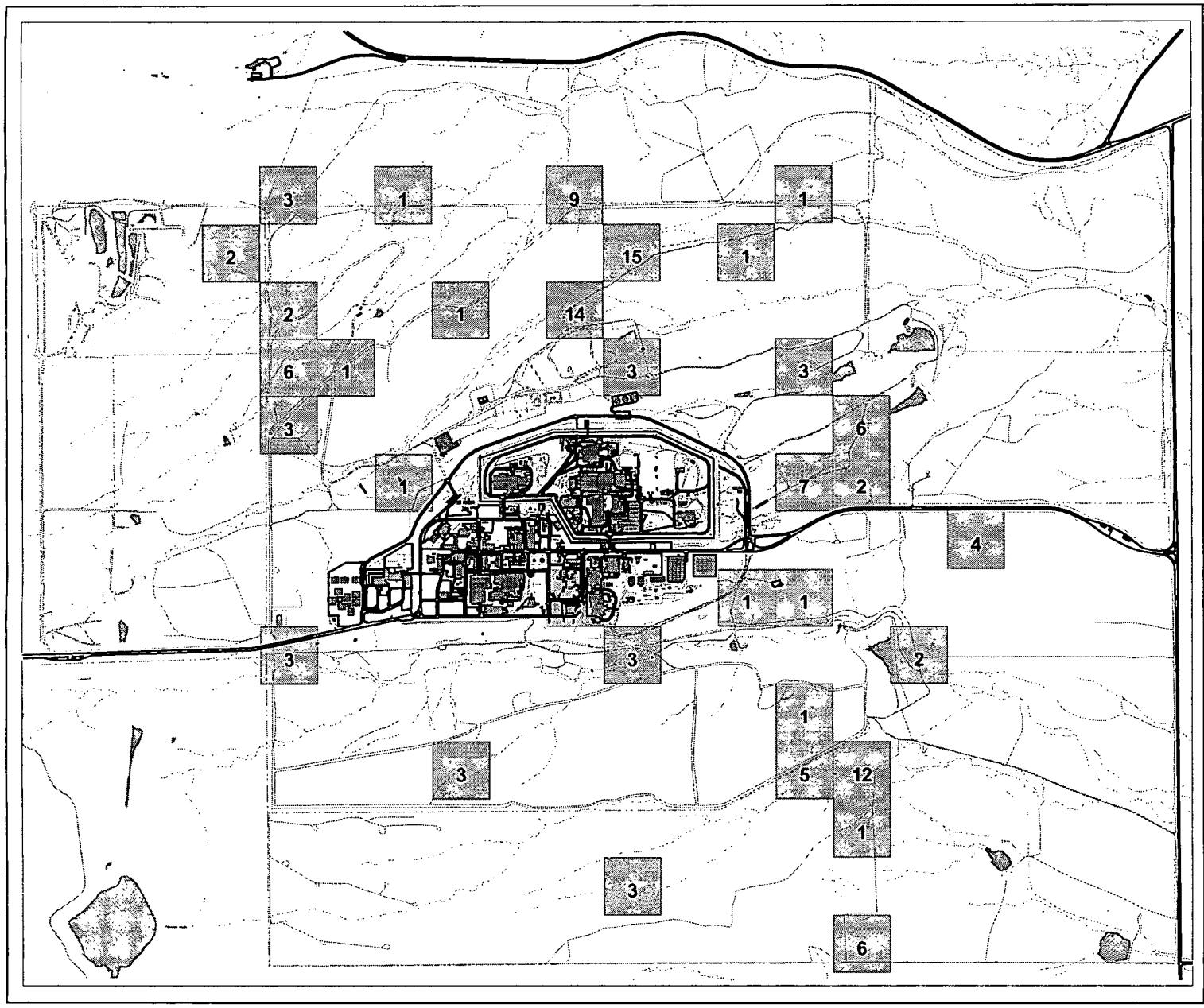

Mule deer
area use in fall.

Figure 3-6.

MAP LEGEND

Rocky Flats grid cell with mule deer occurence. Number indicates total individuals.

Standard Map Features
- Dirt roads
- Paved Roads
- Streams
- Fences
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

N

1:32000

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-Mule Deer Fall

April 28, 1999

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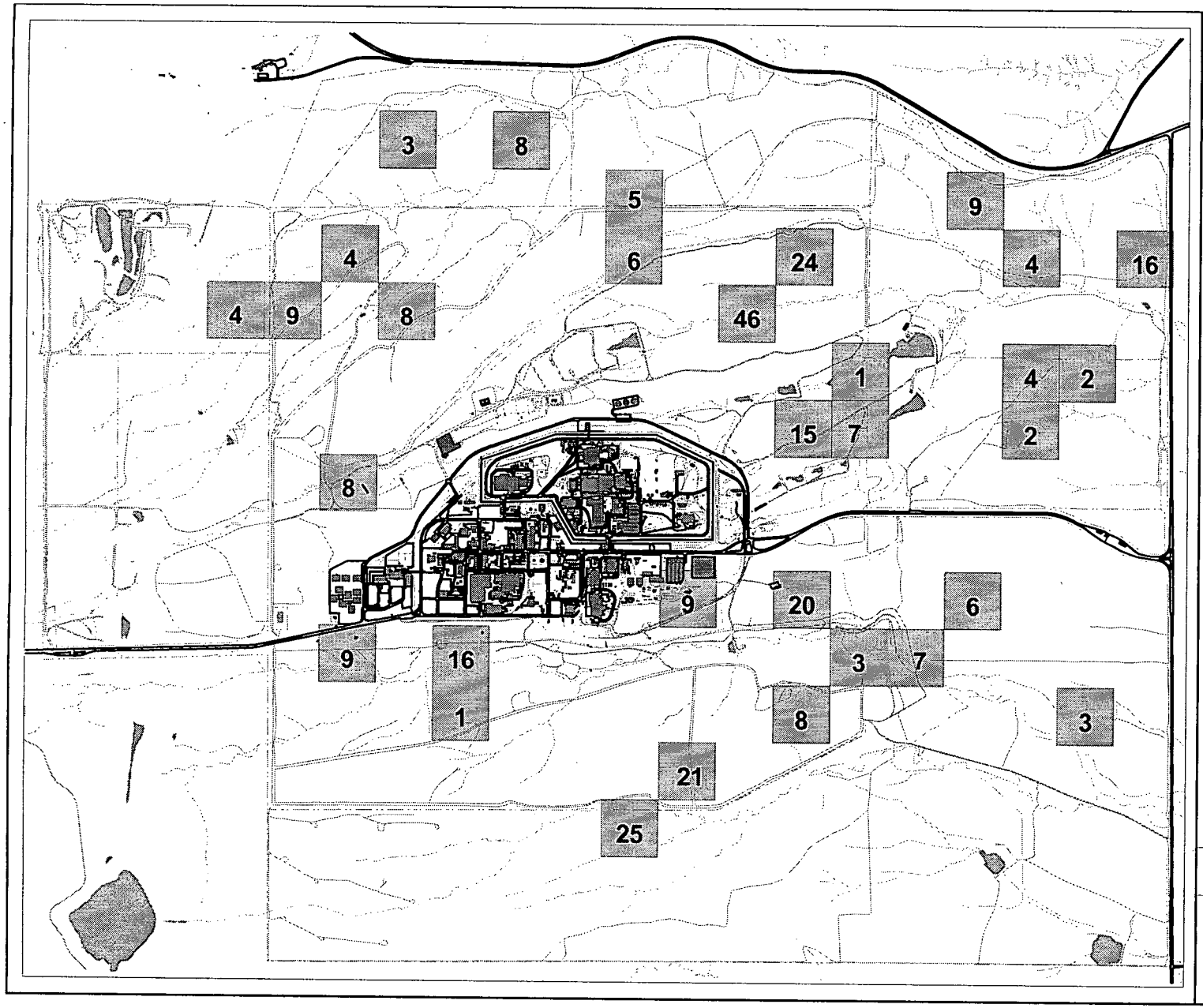


Mule deer
area use in winter.

Figure 3-7.

MAP LEGEND

Rocky Flats grid cell with mule deer occurence. Number indicates total individuals.

Standard Map Features
- Dirt roads
- Paved Roads
- Streams
- Fences
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

N

1:32000
1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

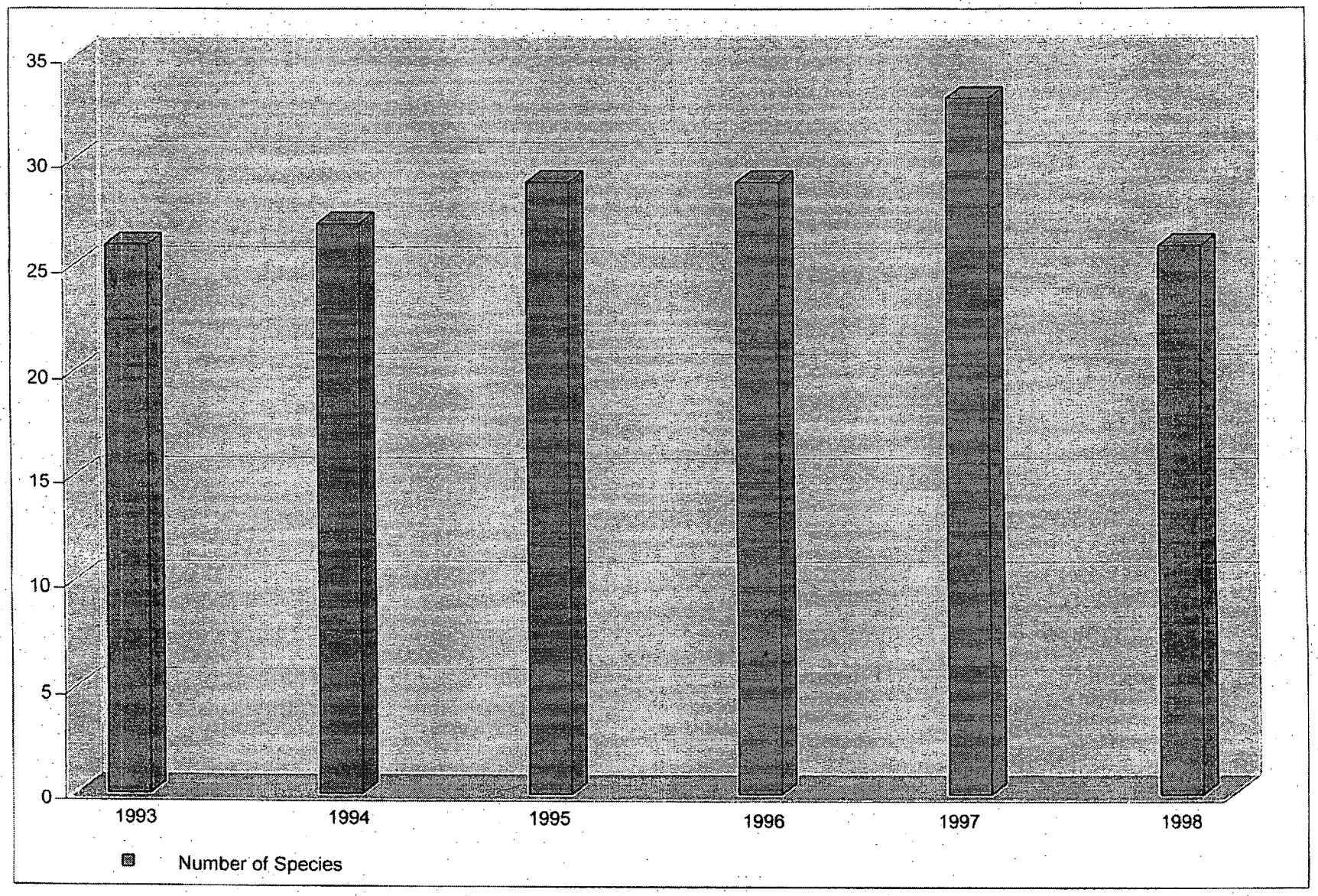
U.S. Department of Energy
Rocky Flats Environmental Technology Site

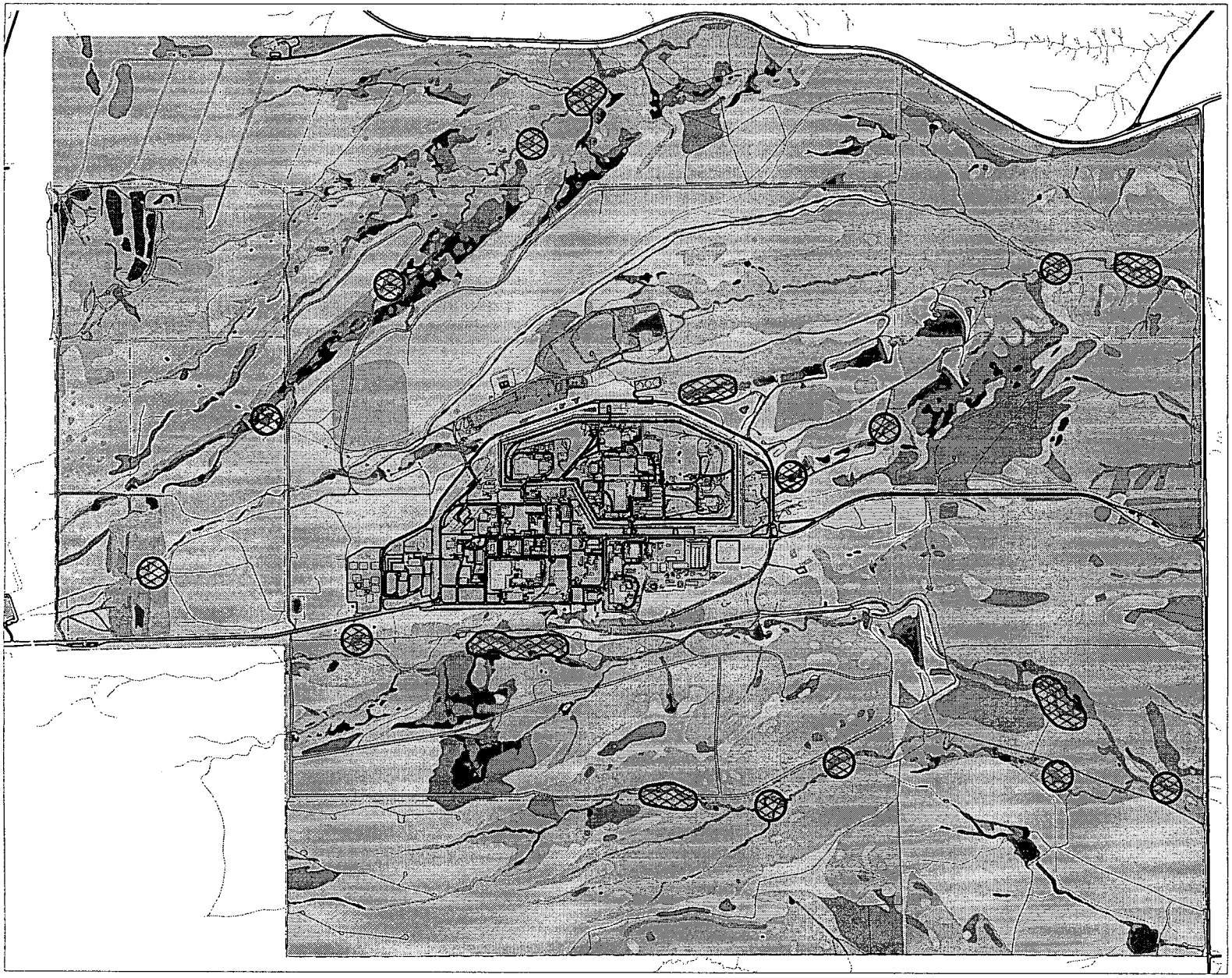
Prepared by: Exponent
For: Kaiser-Hill Company, LLC

MAP ID: mmf99-Mule Deer Winter
April 28, 1999

C:\My Documents\ArcView\ra98.apr

FIGURE 3-8. WATERFOWL SPECIES RECORDED AT ROCKY FLATS ANNUALLY (1993-1998)





Raptor nesting areas
in the Rocky Flats Buffer Zone.

Figure 3-9.

MAP LEGEND

Raptor nesting areas

Vegetation Types
- Annual Grass/Forb Community
- Disturbed and Developed Areas
- Leadplant Riparian Shrubland
- Mesic Mixed Grassland
- Mudflats
- Open Water
- Ponderosa Woodland
- Reclaimed Mixed Grassland
- Riparian Woodland
- Riprap, Rock, and Gravel Piles
- Savannah Shrubland
- Short Grassland
- Short Marsh
- Short Upland Shrubland
- Tall Marsh
- Tall Upland Shrubland
- Tree Plantings
- Wet Meadow/Marsh Ecotone
- Willow Riparian Shrubland
- Xeric Needle and Thread Grass Prairie
- Xeric Tallgrass Prairie

Standard Map Features
- Streams
- Fences
- Dirt roads
- Paved roads
- Buildings

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas
Digitized from the orthophotographs, 1995
Vegetation types and wildlife data provided by Exponent.

N

1:21553

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent™

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-98 Raptor Tabloid

April 27, 1999

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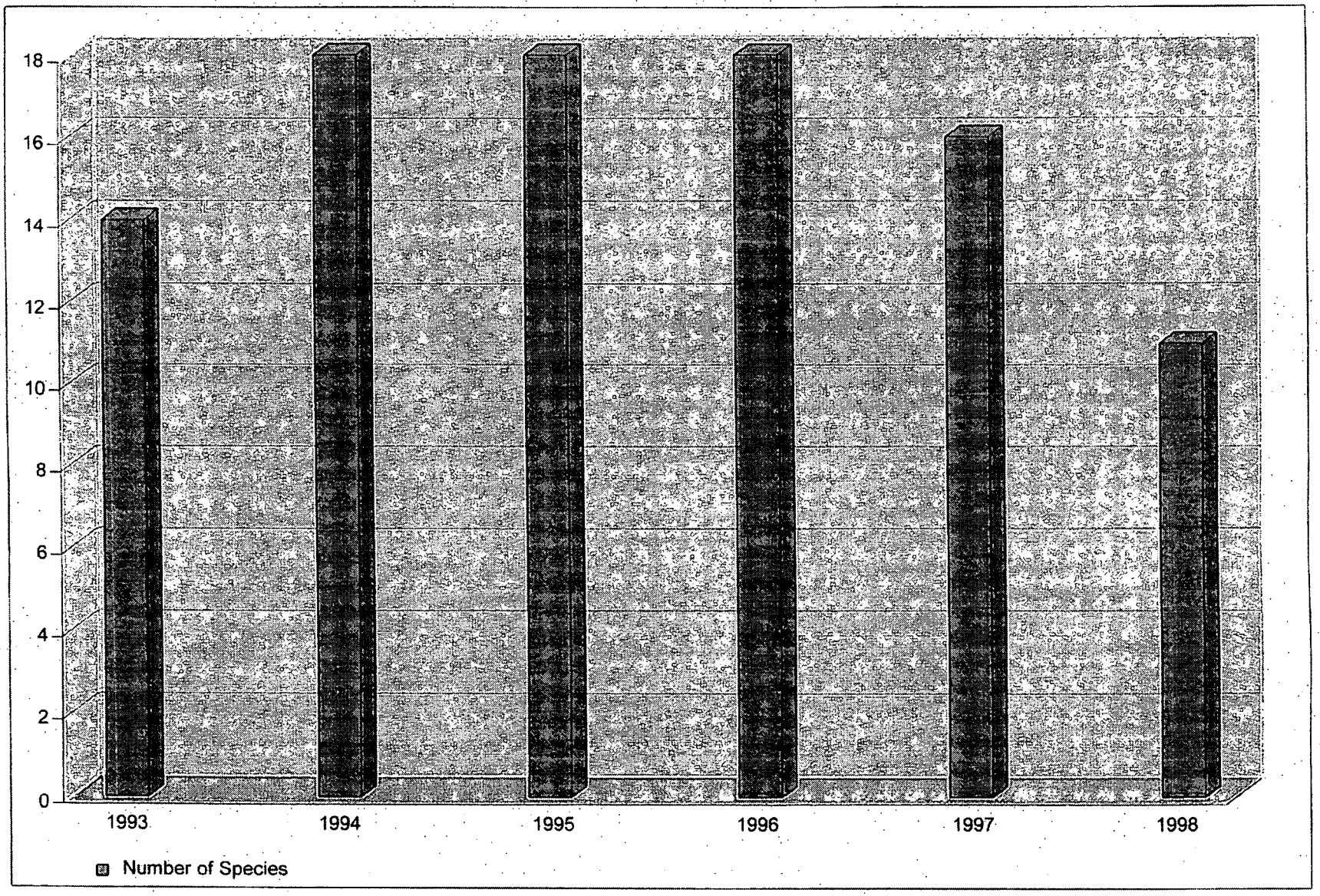
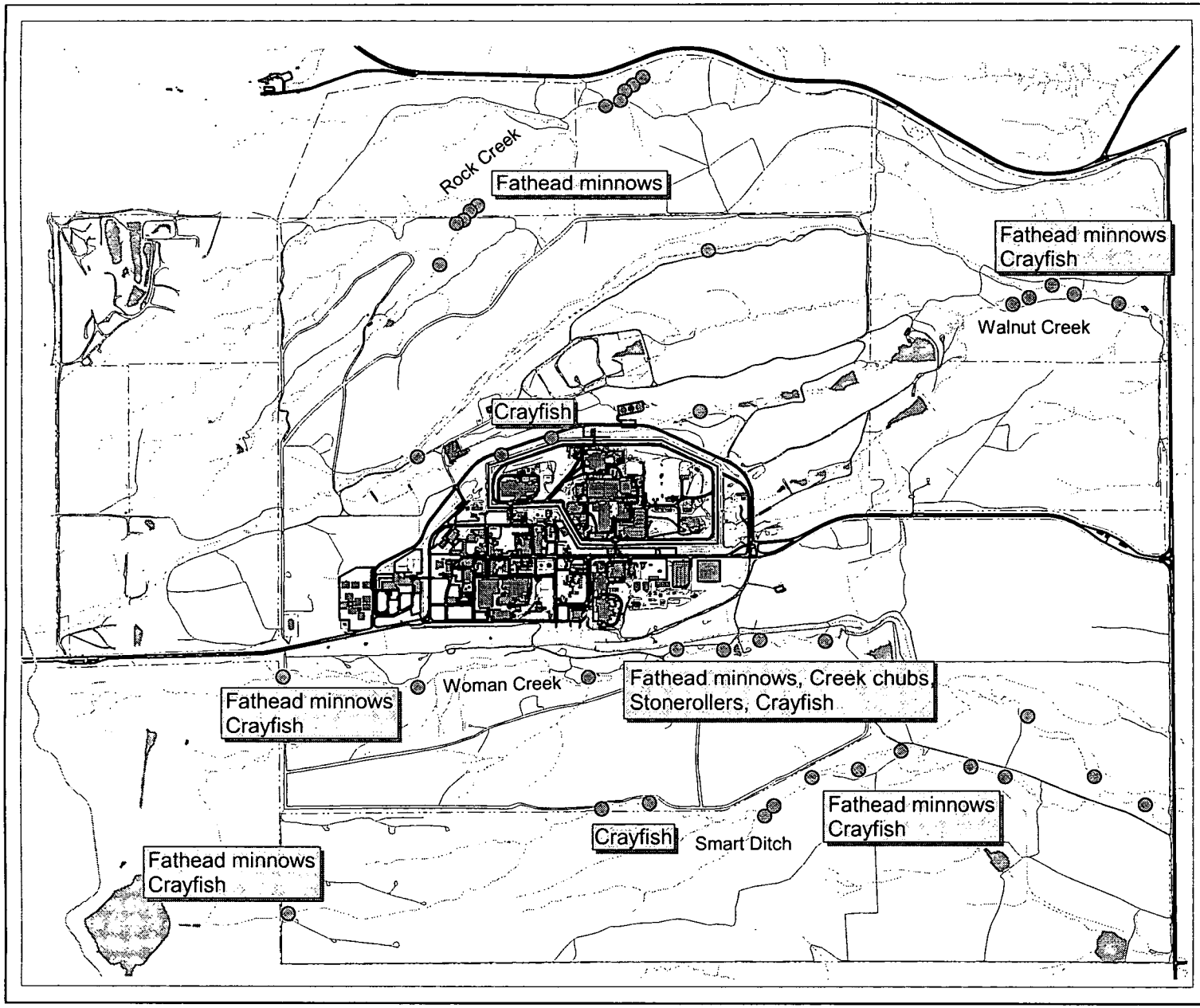
FIGURE 3-10. RAPTOR SPECIES RECORDED AT ROCKY FLATS ANUALLY (1993-1998)





Locations of 1998 fish sampling.

Figure 3-11.

MAP LEGEND

1998 fish sampling locations

Standard Map Features

- Dirt roads
- Paved Roads
- Streams
- Fences
- Buildings
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

1:32639

1000 0 1000 2000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-98fish Letter

April 27, 1999

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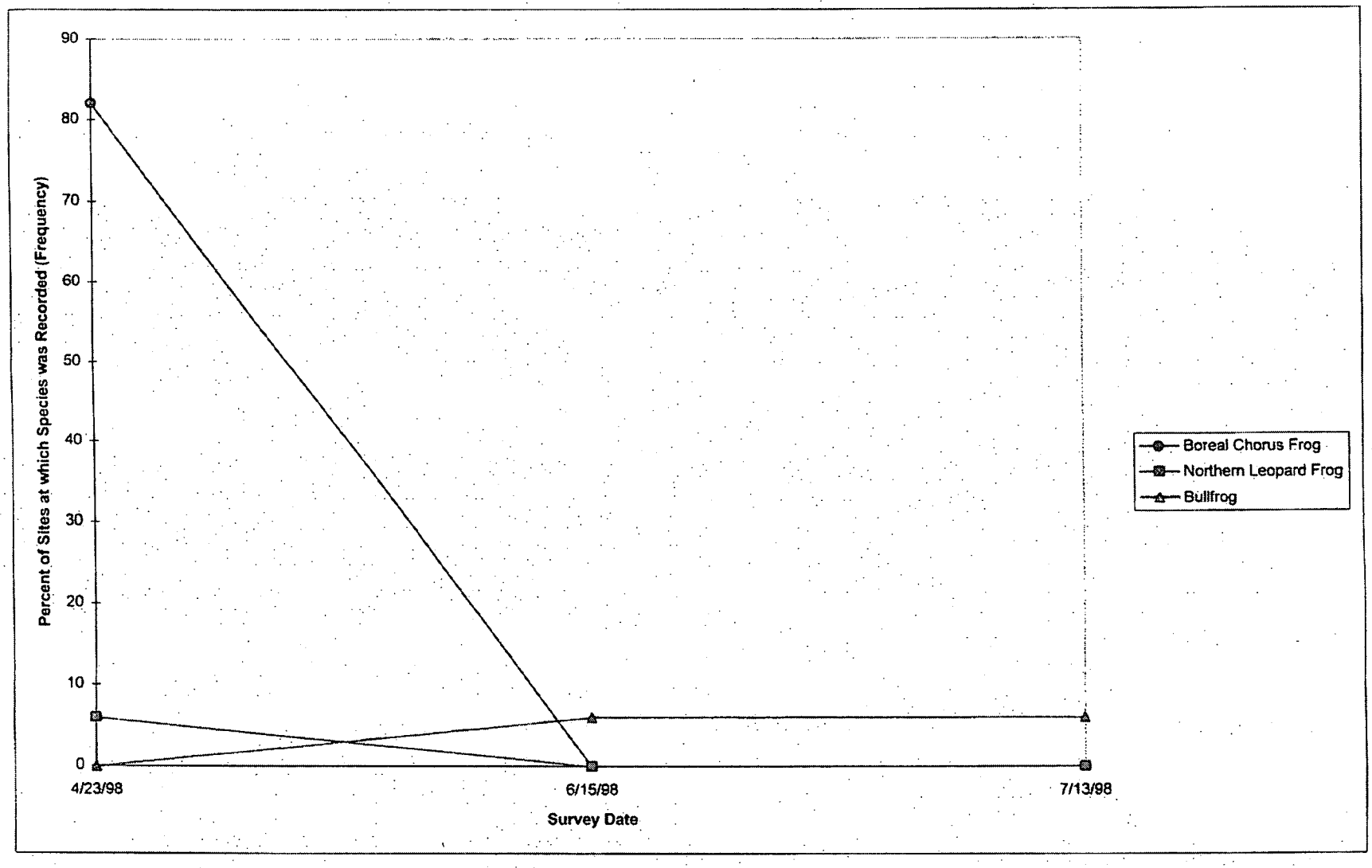
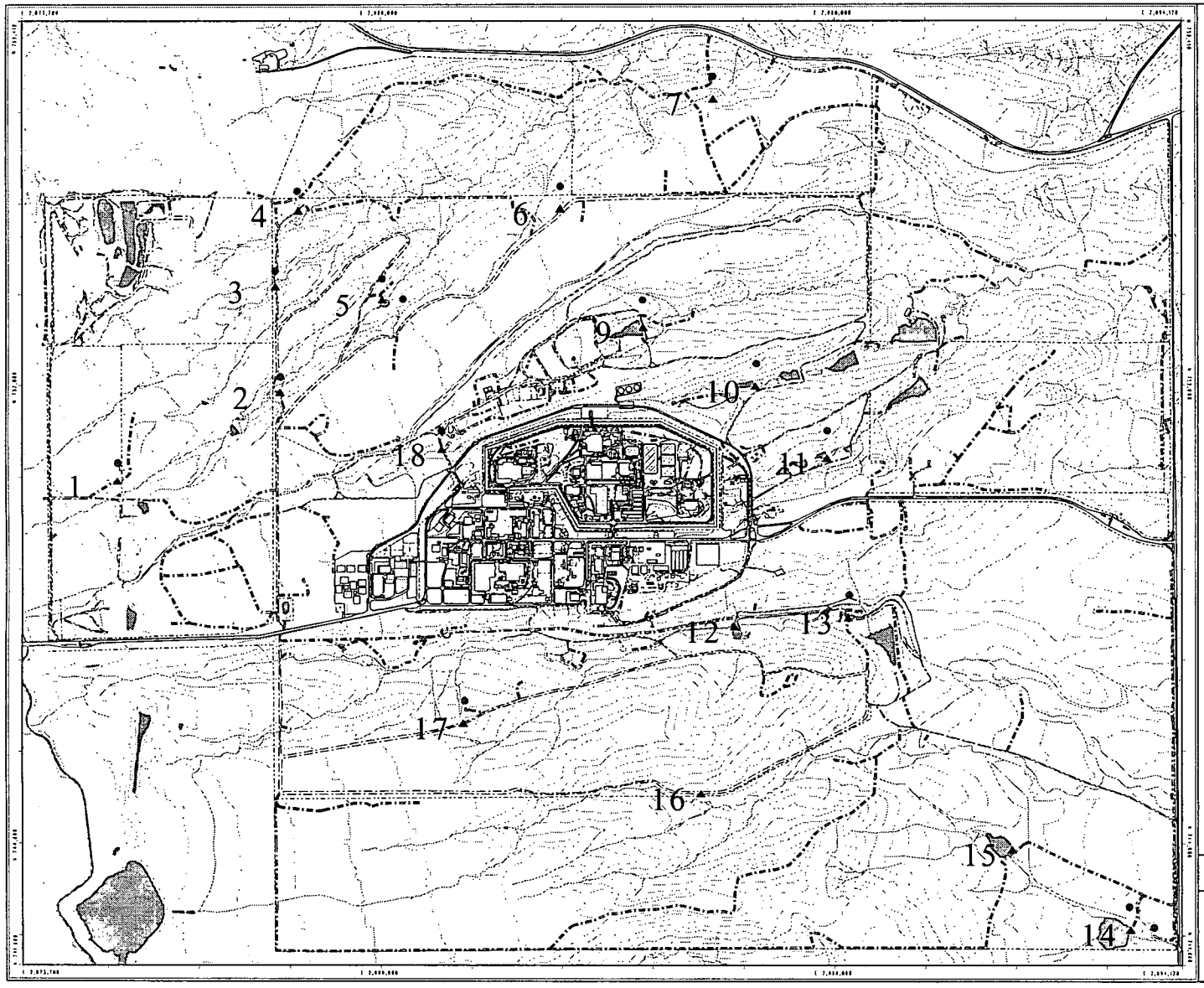
FIGURE 3-12. RESULTS OF THREE FROG VOCALIZATION SURVEYS IN 1998





1998 Frog and Toad Vocalization Results
Figure 3-13

EXPLANATION

- Frog and Toad Vocalization Survey Locations
- Boreal Chorus Frog Vocalization Locations
- Northern Leopard Frog Vocalization Locations
- Bullfrog Vocalization Locations

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
1998 Frog and Toad Vocalization Survey locations recorded by Exponent Environmental Group. Locations are approximate.

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000Ft

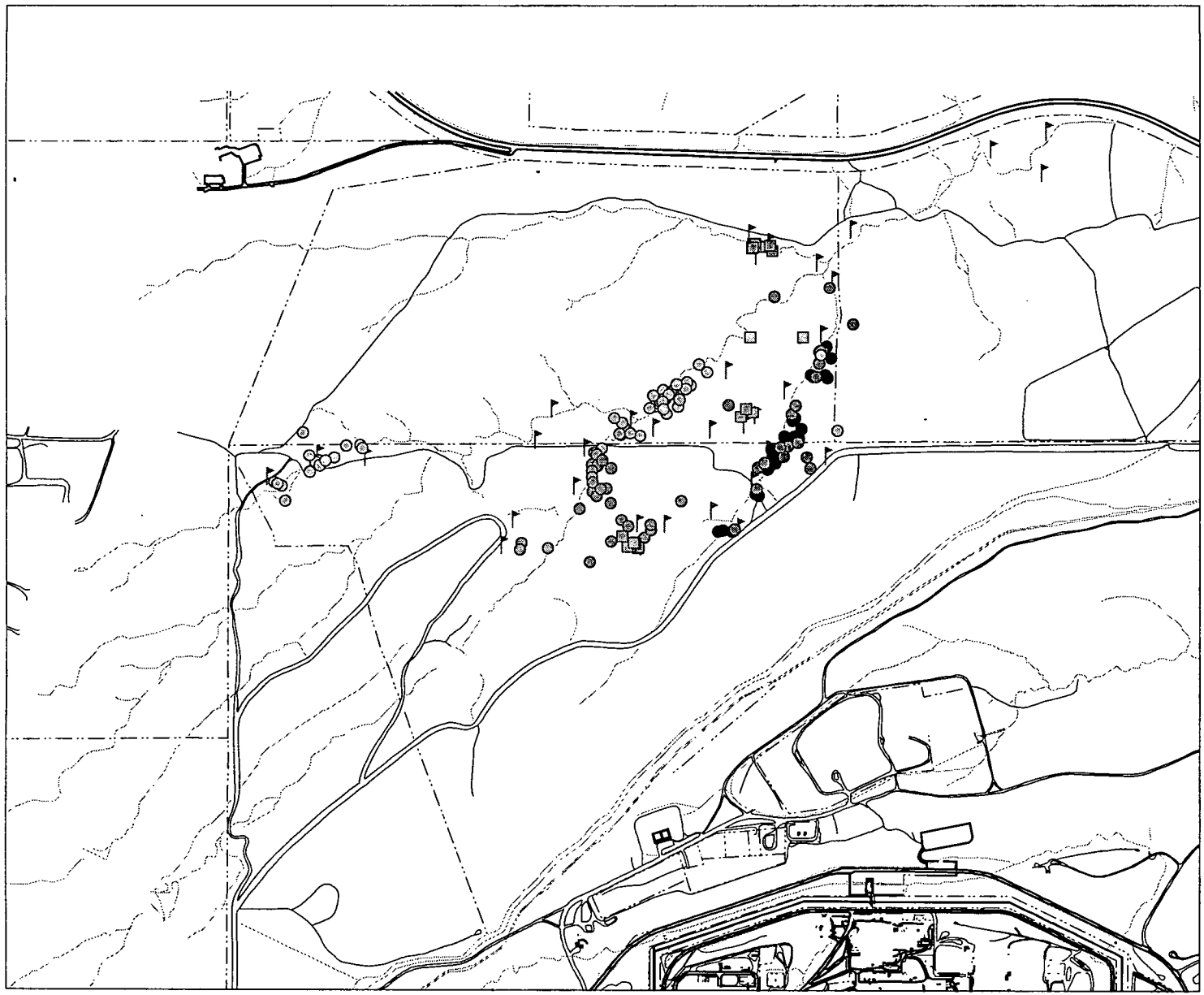
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
Exponent

MAP ID: /home/rS19655/ August 25, 1999

NT_Svr c:/mydocu~1/arcinfo/coverage/frog98.aml



Locations of collared Preble's mice in Rock Creek, 1998.

Figure 3-14.

MAP LEGEND

- Waystations

Preble's mice

- Fall Mouse 1
- Fall Mouse 2
- Summer Mouse 1
- Summer Mouse 2
- Summer Mouse 3
- Summer Mouse 4
- Summer Mouse 5
- Summer Mouse 6

Standard Map Features

- Dirt Roads
- Fences
- Paved Roads
- Streams

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.

N

1:16317

500 0 500 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-fig3-14

April 26, 1999

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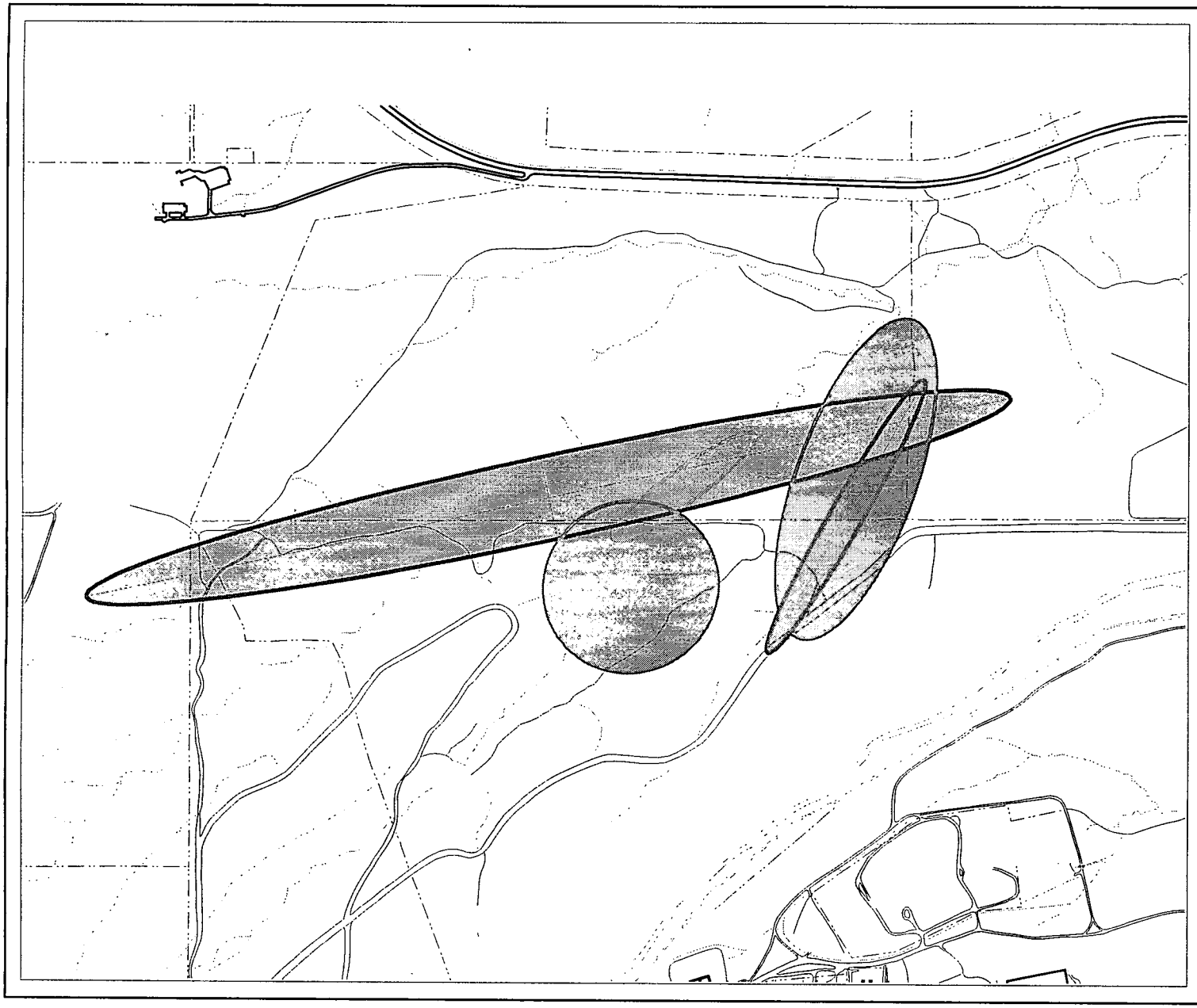

Jennrich-Turner home range estimation of collared Preble's meadow jumping mice using 90% probability ellipse.

Figure 3-15.

MAP LEGEND

Collar Frequency
- 172.311
- 172.391
- 172.493
- 172.515
- 172.562

Standard Map Features
- Dirt roads
- Paved Roads
- Streams
- Fences

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

1:13494

500 0 500 1000 Feet

Universal Transverse Mercator Projection
Zone 13
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

Map ID: mmf99-PMJMhome

April 26, 1999

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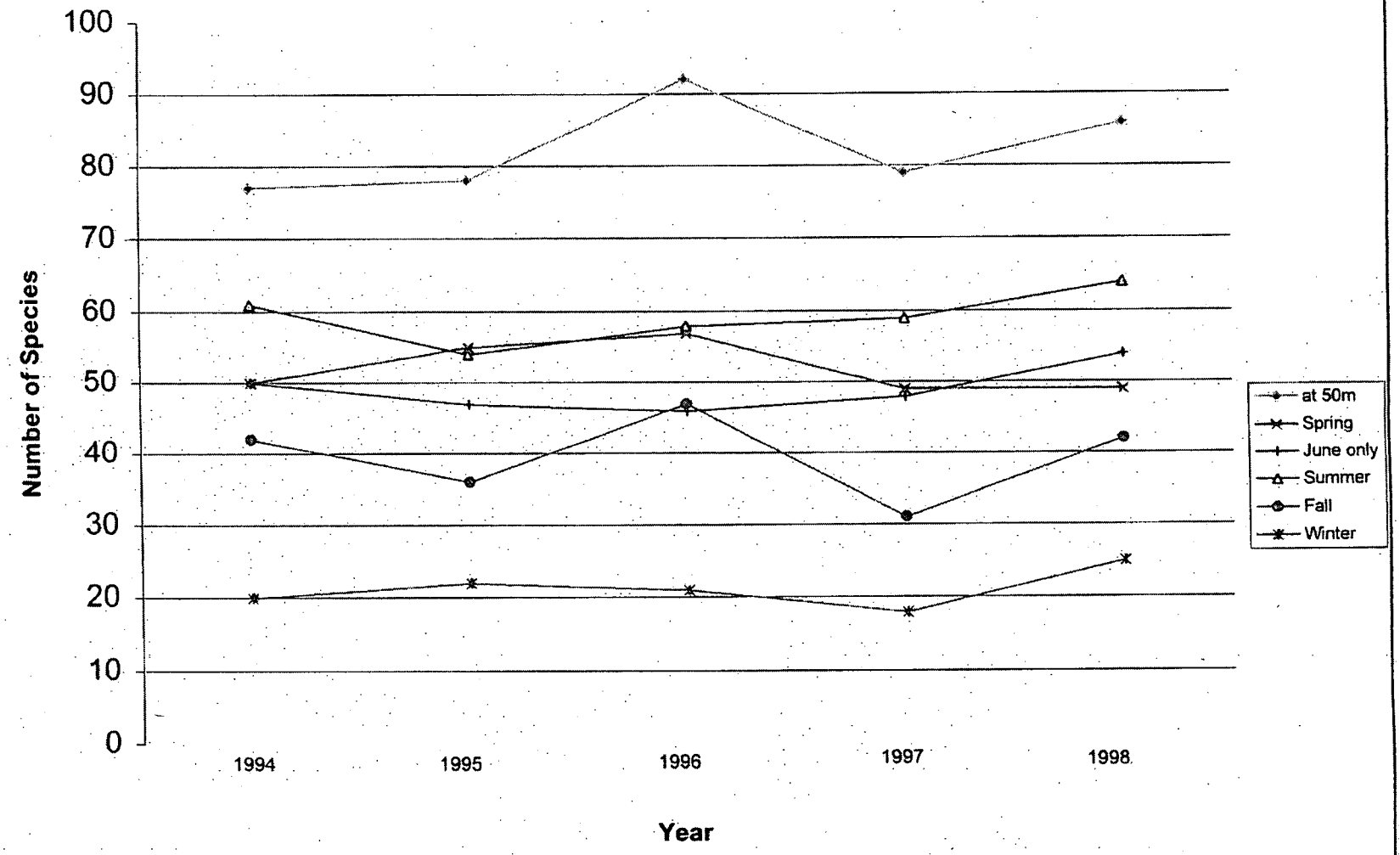
FIGURE 3-16. SPECIES RICHNESS ACROSS ALL COMMUNITY TYPES, 1994-1998



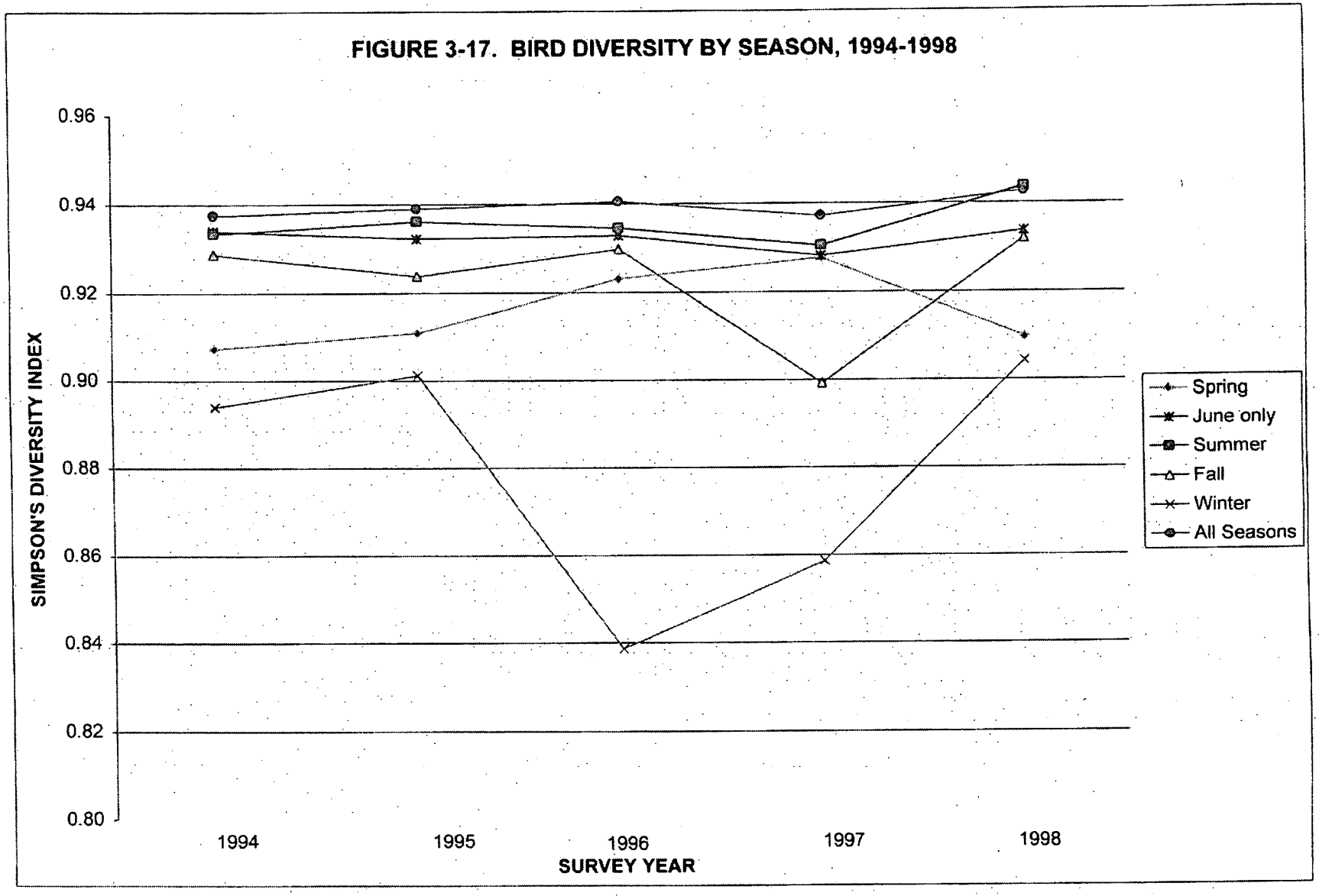


FIGURE 3-17. BIRD DIVERSITY BY SEASON, 1994-1998
SIMPSON'S DIVERSITY INDEX
0.96
0.94
0.92
0.90
0.88
0.86
0.84
0.82
0.80
1994
1995
1996
1997
1998
SURVEY YEAR
Spring
June only
Summer
Fall
Winter
All Seasons

FIGURE 3-18. DIVERSITY INDEX BY HABITAT FOR ALL YEARS DURING JUNE

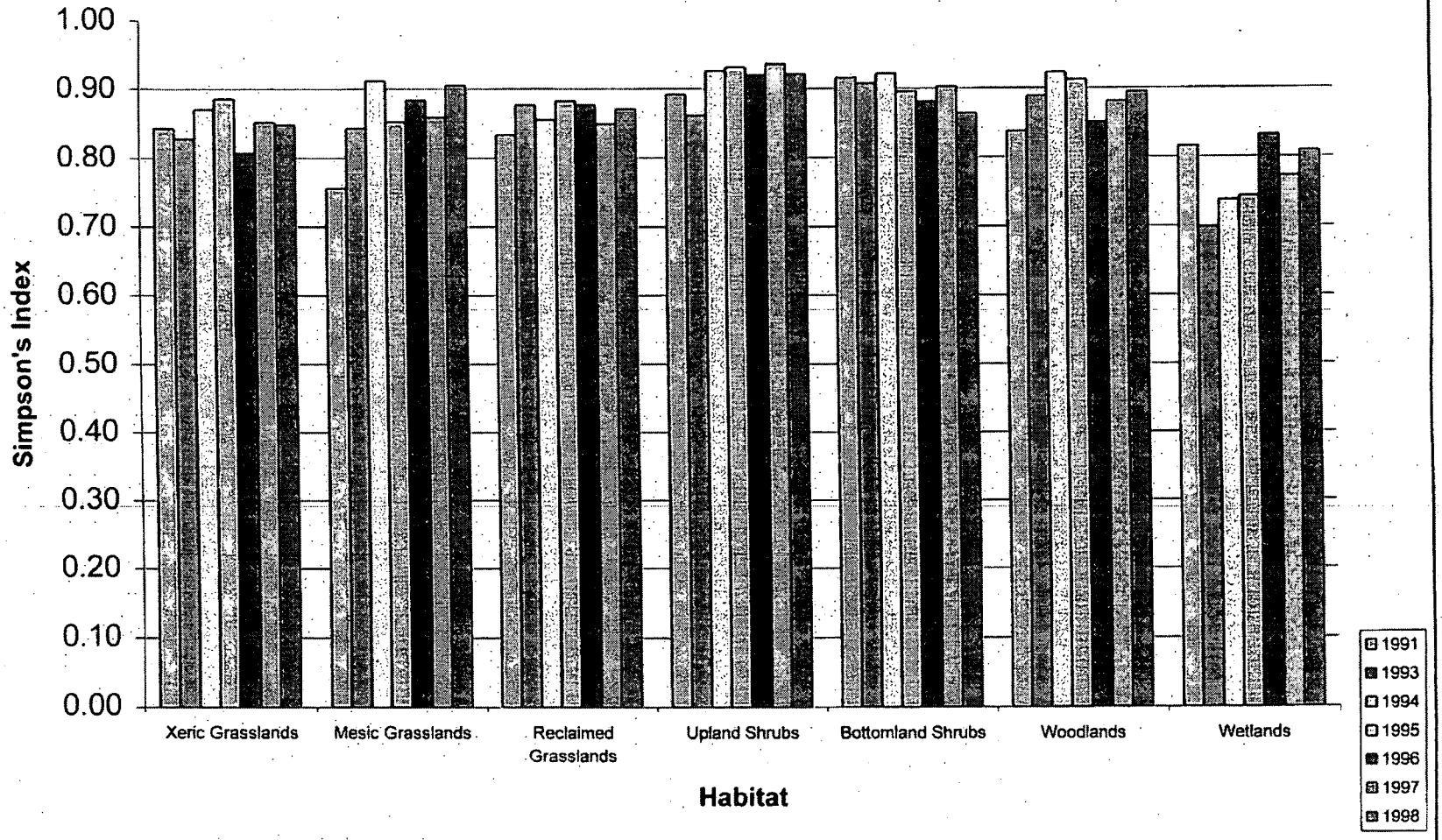


FIGURE 3-19. DENSITIES (birds/sq. km) OF BREEDING BIRDS BY HABITAT (1991, 1993-1998)

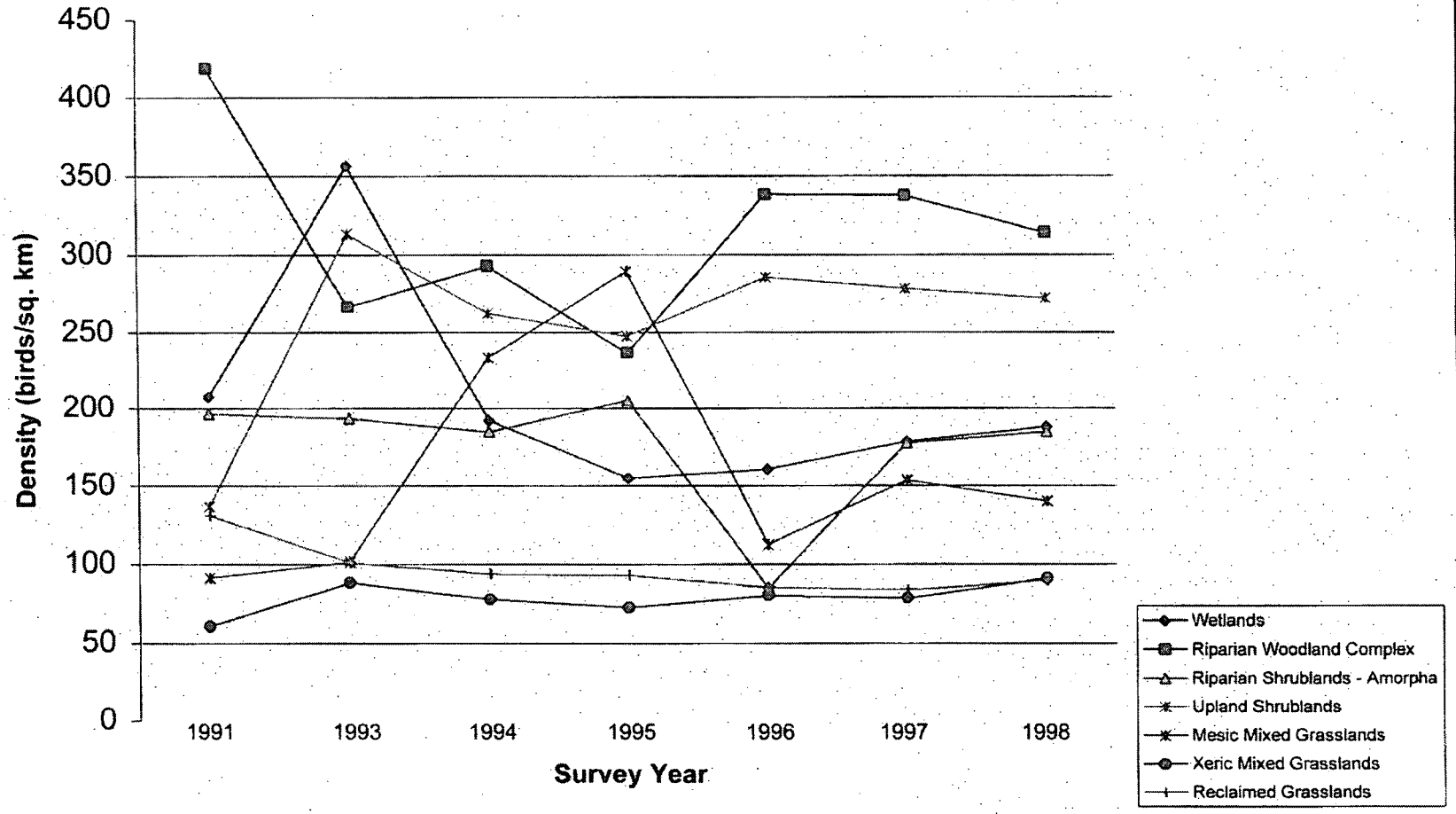


Table 3-1. Big game area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
Spring										
	Mule Deer	ODHE1	3	L	323	6		6		
	Mule Deer	ODHE1	5	F	322/323	9	1	6	2	
	Mule Deer	ODHE1	5	Q	322	3	2	1		
	Mule Deer	ODHE1	6	O	322	7				7
	Mule Deer	ODHE1	7	O	322	4				4
	Mule Deer	ODHE1	7	F	110	3	2	1		
	Mule Deer	ODHE1	7	K	322	30	5	10	3	12
	Mule Deer	ODHE1	7	M	322	31	1			30
	Mule Deer	ODHE1	7	N	110	4	4			
	Mule Deer	ODHE1	7	P	322	4				4
	Mule Deer	ODHE1	7	S	322	6				6
	Mule Deer	ODHE1	8	P	324	2	1	1		
	Mule Deer	ODHE1	9	F	323	11				11
	Mule Deer	ODHE1	10	E	323	8				8
	Mule Deer	ODHE1	10	G	120	4	1	3		
	Mule Deer	ODHE1	10	P	230/322	5		5		
	Mule Deer	ODHE1	11	E	322	1		1		
	Mule Deer	ODHE1	11	O	322	8		6	2	
	Mule Deer	ODHE1	12	P	322	10	5		1	4
	Mule Deer	ODHE1	13	F	230	2		2		
	Mule Deer	ODHE1	13	H	322/323	31	1	14	6	10
	Mule Deer	ODHE1	13	N	322	3	2			1
	Mule Deer	ODHE1	14	F	230	3				3
	Mule Deer	ODHE1	15	J	20	2		2		
	Mule Deer	ODHE1	15	K	10/322	16		1		15
	Mule Deer	ODHE1	15	M	323	4	4			
	Mule Deer	ODHE1	15	O	322	15	9	6		
	White-tailed Deer	ODVI1	4	R	324	6	2	3	1	
	White-tailed Deer	ODVI1	11	O	322	1		1		
Summer										
	Mule Deer	ODHE1	2	N	322	2		1	1	
	Mule Deer	ODHE1	2	Q	322	1		1		
	Mule Deer	ODHE1	4	I	322	3	2	1		
	Mule Deer	ODHE1	4	J	322	2		2		

Table 3-1. Big game area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
	Mule Deer	ODHE1	6	I	130/323	2	1	1		
	Mule Deer	ODHE1	7	J	322	2	1	1		
	Mule Deer	ODHE1	7	L	322	1		1		
	Mule Deer	ODHE1	8	N	322	1	1			
	Mule Deer	ODHE1	8	S	322	1		1		
	Mule Deer	ODHE1	10	F	324	2		2		
	Mule Deer	ODHE1	10	G	322	5	5			
	Mule Deer	ODHE1	10	P	322	2		2		
	Mule Deer	ODHE1	11	J	324	1		1		
	Mule Deer	ODHE1	12	F	30	1	1			
	Mule Deer	ODHE1	12	O	322	1		1		
	Mule Deer	ODHE1	12	P	322	4		2	2	
	Mule Deer	ODHE1	13	F	230	4		4		
	Mule Deer	ODHE1	13	P	322	1		1		
	Mule Deer	ODHE1	14	F	323	1		1		
	Mule Deer	ODHE1	14	H	323	2		2		
	Mule Deer	ODHE1	14	L	323	1		1		
	Mule Deer	ODHE1	14	M	323	1	1			
	Mule Deer	ODHE1	14	O	322	2	2			
	Mule Deer	ODHE1	14	P	322	1		1		
	Mule Deer	ODHE1	15	G	230	1	1			
	Mule Deer	ODHE1	15	K	230	1	1			
	Mule Deer	ODHE1	16	K	322	2	2			
	White-tailed Deer	ODVI1	2	O	322	8	3	3	2	
Fall										
	Mule Deer	ODHE1	2	P	322	6	4	1	1	
	Mule Deer	ODHE1	3	L	322	3				3
	Mule Deer	ODHE1	4	P	322	1	1			
	Mule Deer	ODHE1	5	I	20	3	3			
	Mule Deer	ODHE1	5	O	110	5		3	2	
	Mule Deer	ODHE1	5	P	322	12	4	5	3	
	Mule Deer	ODHE1	6	O	322	1	1			
	Mule Deer	ODHE1	7	F	322	3	2	1		
	Mule Deer	ODHE1	7	L	322	3	3			
	Mule Deer	ODHE1	7	Q	324	2		1	1	

Table 3-1. Big game area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
	Mule Deer	ODHE1	8	K	420	3		2	1	
	Mule Deer	ODHE1	8	N	322	1				1
	Mule Deer	ODHE1	8	O	322	1		1		
	Mule Deer	ODHE1	9	R	322	4	1	2	1	
	Mule Deer	ODHE1	10	H	323	1		1		
	Mule Deer	ODHE1	10	O	20/322	7	1	4	2	
	Mule Deer	ODHE1	10	P	322	2		2		
	Mule Deer	ODHE1	11	F	323	3		3		
	Mule Deer	ODHE1	11	P	110	6	1	4	1	
	Mule Deer	ODHE1	12	F	322	6				6
	Mule Deer	ODHE1	12	G	323	1		1		
	Mule Deer	ODHE1	12	L	322	3				3
	Mule Deer	ODHE1	12	O	93	3	3			
	Mule Deer	ODHE1	13	F	230/322	2	1			1
	Mule Deer	ODHE1	13	I	323	1				1
	Mule Deer	ODHE1	13	K	322/324	14	2	7	5	
	Mule Deer	ODHE1	14	E	322	2		2		
	Mule Deer	ODHE1	14	L	323	15	3	9	3	
	Mule Deer	ODHE1	14	N	322	1	1			
	Mule Deer	ODHE1	15	F	20	3	3			
	Mule Deer	ODHE1	15	H	322	1	1			
	Mule Deer	ODHE1	15	K	230	9	1	6	2	
	Mule Deer	ODHE1	15	O	323	1				1
Winter										
	Mule Deer	ODHE1	4	L	322	25	9	12	4	
	Mule Deer	ODHE1	5	M	322	21	9	9	3	
	Mule Deer	ODHE1	6	I	10	1		1		
	Mule Deer	ODHE1	6	O	322	8		5	3	
	Mule Deer	ODHE1	6	T	322	3	3			
	Mule Deer	ODHE1	7	G	110	9		7	2	
	Mule Deer	ODHE1	7	I	322	13	1	10	2	
	Mule Deer	ODHE1	7	I	212	3	1	1	1	
	Mule Deer	ODHE1	7	P	322	3		1	2	
	Mule Deer	ODHE1	7	Q	322	7		6	1	
	Mule Deer	ODHE1	8	M	322	9		5	4	

Table 3-1. Big game area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
	Mule Deer	ODHE1	8	O	322	20	1	15	4	
	Mule Deer	ODHE1	8	R	322	6	2	3	1	
	Mule Deer	ODHE1	10	G	322	8		4	4	
	Mule Deer	ODHE1	11	O	322/323	15	4	4	7	
	Mule Deer	ODHE1	11	P	212	7	1	4	2	
	Mule Deer	ODHE1	11	S	322	2	2			
	Mule Deer	ODHE1	12	P	322	1	1			
	Mule Deer	ODHE1	12	S	322	4	4			
	Mule Deer	ODHE1	12	T	322	2	2			
	Mule Deer	ODHE1	13	E	322	4	4			
	Mule Deer	ODHE1	13	F	322	9	2	5	2	
	Mule Deer	ODHE1	13	H	322	8		4	4	
	Mule Deer	ODHE1	13	N	322	46	5	8	5	28
	Mule Deer	ODHE1	14	G	323	4		3	1	
	Mule Deer	ODHE1	14	L	323	6	2	2	2	
	Mule Deer	ODHE1	14	O	322	24	7	11	6	
	Mule Deer	ODHE1	14	S	230	4		3	1	
	Mule Deer	ODHE1	14	U	322	16	16			
	Mule Deer	ODHE1	15	L	322	5	1	2	2	
	Mule Deer	ODHE1	15	R	322	9	9			
	Mule Deer	ODHE1	16	H	323	3	2	1		
	Mule Deer	ODHE1	16	J	322	8	3	4	1	
	White-tailed Deer	ODVI1	2	O	322	6	2	3	1	
	White-tailed Deer	ODVI1	11	P	212	1		1		
	White-tailed Deer	ODVI1	14	O	322	1		1		

Table 3-2. Big game relative abundance by habitat in 1998 based on multi-species census surveys

Season	Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/ Habtype
Spring							
	Mule deer	20	6	120	0.050	191	3.14
	Mule deer	110	44	337	0.131	191	23.04
	Mule deer	230	39	176	0.222	191	20.42
	Mule deer	322	85	100	0.850	191	44.50
	Mule deer	323	17	134	0.127	191	8.90
	White-tailed deer	110	2	337	0.006	2	100.00
Summer							
	Mule deer	10	1	49	0.020	70	1.43
	Mule deer	20	5	74	0.068	70	7.14
	Mule deer	30	6	111	0.054	70	8.57
	Mule deer	93	2	28	0.071	70	2.86
	Mule deer	110	18	352	0.051	70	25.71
	Mule deer	211	2	50	0.040	70	2.86
	Mule deer	212	10	79	0.127	70	14.29
	Mule deer	230	18	159	0.113	70	25.71
	Mule deer	322	3	67	0.045	70	4.29
	Mule deer	323	4	170	0.024	70	5.71
	Mule deer	324	1	28	0.036	70	1.43
	White-tailed deer	30	3	111	0.027	4	75.00
	White-tailed deer	211	1	50	0.020	4	25.00
Fall							
	Elk (Wapiti)	30	1	87	0.011	1	100.00
	Mule deer	10	12	50	0.240	167	7.19
	Mule deer	20	7	88	0.080	167	4.19
	Mule deer	30	1	87	0.011	167	0.60
	Mule deer	110	62	310	0.200	167	37.13
	Mule deer	211	1	35	0.029	167	0.60
	Mule deer	212	17	79	0.215	167	10.18
	Mule deer	230	31	164	0.189	167	18.56
	Mule deer	322	24	90	0.267	167	14.37
	Mule deer	323	3	138	0.022	167	1.80
	Mule deer	324	9	29	0.310	167	5.39
	White-tailed deer	110	2	310	0.006	5	40.00
	White-tailed deer	230	3	164	0.018	5	60.00
Winter							
	Elk (Wapiti)	230	1	137	0.007	1	100.00
	Mule deer	20	4	126	0.032	137	2.92
	Mule deer	110	8	300	0.027	137	5.84
	Mule deer	212	1	94	0.011	137	0.73
	Mule deer	230	34	137	0.248	137	24.82
	Mule deer	322	74	93	0.796	137	54.01
	Mule deer	323	9	114	0.079	137	6.57
	Mule deer	324	7	59	0.119	137	5.11

(1) Relative abundance

Table 3-3. Large rodent and lagomorph area use in 1998 base on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
Spring										
	Black-tailed Prairie Dog	CYLU1	2	O	322	5		1	4	
	Muskrat	ONZI1	3	R	54	1				1
	Desert Cottontail	SYAU1	7	N	540	1				1
	Desert Cottontail	SYAU1	12	Q	520	1				1
Summer										
	Black-tailed Prairie Dog	CYLU1	2	O	322	9				9
	Desert Cottontail	SYAU1	2	O	322	1				1
	Muskrat	ONZI1	7	N	54	1				1
	Desert Cottontail	SYAU1	7	N	420	1				1
	Muskrat	ONZI1	10	O	54	1				1
Fall										
	Muskrat	ONZI1	10	O	54	2				2
	Desert Cottontail	SYAU1	14	L	540	1				1
	Desert Cottontail	SYAU1	14	N	540	1				1
Winter										
	Black-tailed Prairie Dog	CYLU1	2	O	322	5				5
	Desert Cottontail	SYAU1	9	N	540	1			1	

Table 3-4. Lagomorph and large rodent relative abundance by habitat in 1998 based on multi-species census surveys

Season	Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype
Spring							
	Muskrat	54	1	113	0.009	1	100.00
	Desert Cottontail	530	3	5	0.600	3	100.00
Summer							
	Muskrat	54	13	131	0.099	13	100.00
	Desert Cottontail	324	1	28	0.036	2	50.00
	Desert Cottontail	420	1	6	0.167	2	50.00
Winter							
	Common Porcupine	230	1	137	0.007	1	100.00
	Desert Cottontail	530	1	1	1.000	1	100.00

(1) Relative abundance

Table 3-5. Carnivore relative abundance by habitat in 1998 based on multi-species census surveys

Season	Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype
Fall							
	Coyote	20	1	88	0.011	11	9.09
	Coyote	110	1	310	0.003	11	9.09
	Coyote	212	1	79	0.013	11	9.09
	Coyote	230	5	164	0.030	11	45.45
	Coyote	322	2	90	0.022	11	18.18
	Coyote	323	1	138	0.007	11	9.09
Spring							
	Coyote	230	1	176	0.006	4	25.00
	Coyote	322	3	100	0.030	4	75.00
	Mountain lion	322	1	100	0.010	1	100.00
Summer							
	Coyote	20	2	74	0.027	7	28.57
	Coyote	110	1	352	0.003	7	14.29
	Coyote	230	3	159	0.019	7	42.86
	Coyote	322	1	67	0.015	7	14.29
Winter							
	Coyote	30	1	49	0.020	10	10.00
	Coyote	110	2	300	0.007	10	20.00
	Coyote	230	7	137	0.051	10	70.00
	Mountain lion	212	1	94	0.011	2	50.00
	Mountain lion	230	1	137	0.007	2	50.00

(1) Relative abundance

Table 3-6. Carnivore area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Un-Classifed
Spring						
	Coyote	CALA1	2	F	323	1
	Coyote	CALA1	3	N	323	2
	Coyote	CALA1	7	R	322	1
Summer						
	Coyote	CALA1	2	T	93	1
Fall						
	Coyote	CALA1	5	R	211	1
	Coyote	CALA1	12	N	322	2
	Coyote	CALA1	13	E	323	1
	Coyote	CALA1	14	H	20	2
	Coyote	CALA1	14	J	230	1
	Coyote	CALA1	15	L	323	1
Winter						
	Coyote	CALA1	2	G	323	1
	Coyote	CALA1	4	M	322	2
	Coyote	CALA1	4	R	324	1
	Coyote	CALA1	5	I	323	1
	Coyote	CALA1	7	N	20	1
	Coyote	CALA1	15	F	230	1

Table 3-7. Waterfowl area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Group Size	Male	Female	Young	Unclassifed
Spring									
	Green-winged Teal	ANCR1	2	T	2	1	1		
	Mallard	ANPL1	2	T	2	1	1		
	Gadwall	ANST1	2	T	2	1	1		
	Lesser Scaup	AYAF1	2	T	21	1	1		19
	Ring-necked Duck	AYCO1	2	T	26	13	13		
	Canada Goose	BRCA1	2	T	2	1	1		
	Bufflehead	BUAL1	2	T	6	3	3		
	American Coot	FUAM1	2	T	25				25
	Double-crested Cormorant	PHAU1	2	T	1				1
	Redhead	AYAM1	2	U	2	1	1		
	American Coot	FUAM1	2	U	2				2
	Pied-billed Grebe	POPO1	2	U	9				9
	Ring-necked Duck	AYCO1	3	R	9	6	3		
	Canada Goose	BRCA1	3	R	2	1	1		
	American Coot	FUAM1	3	R	1				1
	Pied-billed Grebe	POPO1	3	R	2				2
	American Coot	FUAM1	3	S	3				2
	Lesser Scaup	AYAF1	4	R	5	4	1		
	Pied-billed Grebe	POPO1	4	R	1				1
	Pied-billed Grebe	POPO1	7	N	3				2
	Cinnamon Teal	ANCY1	7	P	4	2	2		
	Mallard	ANPL1	7	P	5	3	2		
	Lesser Scaup	AYAF1	7	P	2	1	1		
	Canada Goose	BRCA1	7	P	2	1	1		
	Bufflehead	BUAL1	7	P	2	1	1		
	Common Goldeneye	BUCL1	7	P	2	1	1		
	Common Merganser	MEME1	7	P	3	1	2		
	Pied-billed Grebe	POPO1	7	P	1				1
	Blue-winged Teal	ANDI1	10	O	2	1	1		
	Mallard	ANPL1	10	O	3	1	1		1
	Lesser Scaup	AYAF1	10	O	2	1	1		
	Canada Goose	BRCA1	10	O	8	4	4		
	Pied-billed Grebe	POPO1	10	O	1				1
	Gadwall	ANST1	10	P	2	1	1		
	Mallard	ANPL1	11	N	1	1			

Table 3-7. Waterfowl area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Group Size	Male	Female	Young	Unclassifed
	Canada Goose	BRCA1	11	N	2	1	1		
	Pied-billed Grebe	POPO1	11	N	1				1
	Redhead	AYAM1	11	P	2	1	1		
	Northern Pintail	ANAC1	11	Q	6	2	4		
	Mallard	ANPL1	11	Q	4	3	1		
	Gadwall	ANST1	11	Q	14	7	7		
	Lesser Scaup	AYAF1	11	Q	15	11	4		
	Bufflehead	BUAL1	11	Q	2	1	1		
	Mallard	ANPL1	12	F	2	1	1		
	American Wigeon	ANAM1	12	L	2	1	1		
	Mallard	ANPL1	12	L	5	3	2		
	Ring-necked Duck	AYCO1	12	L	1	1			
	Canada Goose	BRCA1	12	L	2	1	1		
	Redhead	AYAM1	12	O	1	1			
	Pied-billed Grebe	POPO1	12	O	1				1
	Blue-winged Teal	ANDI1	12	P	3	1	2		
	Mallard	ANPL1	12	P	5	4	1		
	Gadwall	ANST1	12	P	2	1	1		
	Gadwall	ANST1	12	P	2	1	1		
	Bufflehead	BUAL1	12	P	2	1	1		
	Pied-billed Grebe	POPO1	12	P	1	1			
	Green-winged Teal	ANCR1	12	Q	16	10	6		
	Cinnamon Teal	ANCY1	12	Q	1	1			
	Blue-winged Teal	ANDI1	12	Q	5	3	2		
	Mallard	ANPL1	12	Q	24	18	6		
	Great Blue Heron	ARHE1	12	Q	1	1			
	Bufflehead	BUAL1	12	Q	2	1	1		
	Common Goldeneye	BUCL1	12	Q	4	2	2		
	Hooded Merganser	LOCU1	12	Q	3	1	2		
	Double-crested Cormorant	PHAU1	12	Q	2				2
	Green-winged Teal	ANCR1	13	H	1	1			
	Mallard	ANPL1	13	H	3	1	2		
	Great Blue Heron	ARHE1	13	H	1				1
	Mallard	ANPL1	13	L	3	2	1		
	Lesser Scaup	AYAF1	13	L	3	2	1		
	Bufflehead	BUAL1	13	L	2	1	1		

Table 3-7. Waterfowl area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Group Size	Male	Female	Young	Unclassifed
	Pied-billed Grebe	POPO1	13	L	1				1
	Canada Goose	BRCA1	13	P	2	1	1		
	Lesser Scaup	AYAF1	13	Q	1	1			
	Double-crested Cormorant	PHAU1	13	Q	4				4
Summer									
	Blue-winged Teal	ANDI1	2	T	9				9
	Mallard	ANPL1	2	T	45	7	4	2	32
	Gadwall	ANST1	2	T	2	1	1		
	Redhead	AYAM1	2	T	4	2	2		
	Canada Goose	BRCA1	2	T	4				4
	American Coot	FUAM1	2	T	52				52
	Ruddy Duck	OXJA1	2	T	2		2		
	American Coot	FUAM1	2	U	15			1	14
	Double-crested Cormorant	PHAU1	2	U	1				1
	Pied-billed Grebe	POPO1	2	U	14			6	8
	Mallard	ANPL1	3	F	1		1		
	American Coot	FUAM1	3	R	3		1	2	
	Pied-billed Grebe	POPO1	3	R	8			8	
	Mallard	ANPL1	3	S	1		1		
	Double-crested Cormorant	PHAU1	3	S	1				1
	Blue-winged Teal	ANDI1	4	R	1				1
	Pied-billed Grebe	POPO1	4	R	2				2
	Mallard	ANPL1	4	S	2		1	1	
	American Coot	FUAM1	4	S	1				1
	Double-crested Cormorant	PHAU1	7	N	3				3
	Mallard	ANPL1	7	P	2	1	1		
	Great Blue Heron	ARHE1	7	P	1				1
	Double-crested Cormorant	PHAU1	7	P	2			1	1
	Cinnamon Teal	ANCY1	10	O	1	1			
	Blue-winged Teal	ANDI1	10	O	19	2	7	5	5
	Mallard	ANPL1	10	O	13	1	3	9	
	Mallard	ANPL1	10	P	9		2	5	2
	Mallard	ANPL1	11	Q	6		3		3
	Great Blue Heron	ARHE1	11	Q	1				1
	Blue-winged Teal	ANDI1	12	L	1		1		
	Mallard	ANPL1	12	L	2		2		

Table 3-7. Waterfowl area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Group Size	Male	Female	Young	Unclassifed
	Great Blue Heron	ARHE1	12	L	1				1
	Blue-winged Teal	ANDI1	12	N	3			3	
	Mallard	ANPL1	12	N	4	1	2	1	
	Blue-winged Teal	ANDI1	12	O	4		2	2	
	Mallard	ANPL1	12	O	22	1	4	17	
	Great Blue Heron	ARHE1	12	O	1				1
	Double-crested Cormorant	PHAU1	12	O	2				2
	Mallard	ANPL1	12	P	5		2	3	
	Great Blue Heron	ARHE1	12	P	1				1
	Blue-winged Teal	ANDI1	12	Q	1		1		
	Mallard	ANPL1	12	Q	12	3	9	0	0
	Double-crested Cormorant	PHAU1	12	Q	8	0	0	0	8
	Blue-winged Teal	ANDI1	13	H	5		1	4	
	Mallard	ANPL1	13	H	1		1		
	American Coot	FUAM1	13	L	7		1	4	2
	Pied-billed Grebe	POPO1	13	L	1				1
	Great Blue Heron	ARHE1	13	Q	1				1
Fall									
	Bufflehead	BUAL1	2	T	4	2	2		
	Pied-billed Grebe	POPO1	2	T	1				1
	American Coot	FUAM1	2	U	1				1
	Pied-billed Grebe	POPO1	2	U	1				1
	Mallard	ANPL1	3	R	4	3	1		
	Bufflehead	BUAL1	3	R	9	7	2		
	Blue-winged Teal	ANDI1	3	S	1		1		
	Mallard	ANPL1	4	R	6	4	2		
	Pied-billed Grebe	POPO1	4	R	4				4
	Green-winged Teal	ANCR1	10	O	9	6	2		1
	Mallard	ANPL1	10	O	7	5	2		
	Blue-winged Teal	ANDI1	11	Q	2	1	1		
	Bufflehead	BUAL1	11	Q	3	1	2		
	Mallard	ANPL1	12	O	3	3			
	Mallard	ANPL1	12	P	1		1		
	Bufflehead	BUAL1	12	P	2		2		
	Mallard	ANPL1	12	Q	1		1		
	Bufflehead	BUAL1	12	Q	6	3	3		

Table 3-7. Waterfowl area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Group Size	Male	Female	Young	Unclassifed
	Green-winged Teal	ANCR1	13	H	4				4
	Mallard	ANPL1	13	H	2	1	1		
	Bufflehead	BUAL1	13	Q	10	7	3		
Winter									
	Mallard	ANPL1	2	T	2	1	1		
	Lesser Scaup	AYAF1	2	T	1	1			
	Canada Goose	BRCA1	2	T	38	1	1		36
	Bufflehead	BUAL1	2	T	1	1			
	Common Merganser	MEME1	2	T	1	1			
	Mallard	ANPL1	3	R	11	6	5		
	Ring-necked Duck	AYCO1	3	R	13	11	2		
	Canada Goose	BRCA1	3	R	2	1	1		
	Common Merganser	MEME1	3	R	4	1	3		
	Redhead	AYAM1	4	R	7	4	3		
	Common Goldeneye	BUCL1	4	R	3	1	2		
	Mallard	ANPL1	10	P	3	2	1		
	Mallard	ANPL1	11	Q	2	1	1		
	Mallard	ANPL1	12	N	2	1	1		
	Mallard	ANPL1	12	O	14	8	6		
	Redhead	AYAM1	12	O	19		3		16
	Mallard	ANPL1	12	P	2	1	1		
	Redhead	AYAM1	13	Q	2	1	1		
	Mallard	ANPL1	13	U	2	1	1		

Table 3-8. Waterfowl relative abundance in 1998 based on multi-species census surveys

Common Name	Total Obs. in 1998	Obs./Min.(1) of Species in 1998
Mallard	370	0.0781
American Coot	176	0.0371
Blue-winged Teal	93	0.0196
Pied-billed Grebe	75	0.0158
Ring-necked Duck	73	0.0154
Bufflehead	66	0.0139
Green-winged Teal	58	0.0122
Common Snipe	41	0.0087
Killdeer	38	0.0080
Lesser Scaup	32	0.0068
Cinnamon Teal	26	0.0055
Redhead	24	0.0051
Canada Goose	18	0.0038
Double-crested Cormorant	16	0.0034
Great Blue Heron	15	0.0032
Spotted Sandpiper	12	0.0025
Common Goldeneye	10	0.0021
Gadwall	9	0.0019
American White Pelican	5	0.0011
Hooded Merganser	4	0.0008
Common Merganser	3	0.0006
Northern Shoveler	2	0.0004
Sora	2	0.0004
American Wigeon	1	0.0002
Black-crowned Night-heron	1	0.0002
Lesser Yellowlegs	1	0.0002

(1) Relative abundance

Table 3-9. Waterfowl relative abundance in spring 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Spring	Obs./Min. of Species in Spring
Spotted Sandpiper	54	1	113	0.009	50.00		
Spotted Sandpiper	93	1	21	0.048	50.00	2	0.002
Northern Shoveler	54	2	113	0.018	100.00	2	0.002
Green-winged Teal	54	30	113	0.265	100.00	30	0.024
Cinnamon Teal	54	24	113	0.212	100.00	24	0.019
Blue-winged Teal	54	16	113	0.142	84.21		
Blue-winged Teal	93	3	21	0.143	15.79	19	0.015
Mallard	20	4	120	0.033	4.26		
Mallard	43	2	3	0.667	2.13		
Mallard	54	67	113	0.593	71.28		
Mallard	93	8	21	0.381	8.51		
Mallard	110	9	337	0.027	9.57		
Mallard	211	1	30	0.033	1.06		
Mallard	212	2	96	0.021	2.13		
Mallard	230	1	176	0.006	1.06	94	0.075
Gadwall	54	7	113	0.062	100.00	7	0.006
Great Blue Heron	30	2	54	0.037	33.33		
Great Blue Heron	54	3	113	0.027	50.00		
Great Blue Heron	110	1	337	0.003	16.67	6	0.005
Lesser Scaup	54	30	113	0.265	100.00	30	0.024
Redhead	54	5	113	0.044	100.00	5	0.004
Ring-necked Duck	54	49	113	0.434	100.00	49	0.039
Canada Goose	54	10	113	0.088	83.33		
Canada Goose	324	2	24	0.083	16.67	12	0.010
Bufflehead	54	26	113	0.230	100.00	26	0.021
Killdeer	20	3	120	0.025	16.67		
Killdeer	93	11	21	0.524	61.11		
Killdeer	110	3	337	0.009	16.67		
Killdeer	420	1	3	0.333	5.56	18	0.014
American Coot	54	39	113	0.345	100.00	39	0.031
Common Snipe	10	2	46	0.043	5.88		
Common Snipe	20	27	120	0.225	79.41		
Common Snipe	30	3	54	0.056	8.82		
Common Snipe	110	1	337	0.003	2.94		
Common Snipe	211	1	30	0.033	2.94	34	0.027
American White Pelican	54	2	113	0.018	100.00	2	0.002
Double-crested	54	5	113	0.044	83.33		
Double-crested	93	1	21	0.048	16.67	6	0.005
Pied-billed Grebe	54	16	113	0.142	100.00	16	0.013

(1) Relative abundance

Table 3-10. Waterfowl relative abundance in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/ Habtype	Total Obs. in Summer	Obs./Min. of Species in Summer
Spotted Sandpiper	54	5	131	0.038	50.00		
Spotted Sandpiper	93	5	28	0.179	50.00	10	0.008
Green-winged Teal	54	2	131	0.015	100.00	2	0.002
Cinnamon Teal	54	2	131	0.015	100.00	2	0.002
Blue-winged Teal	54	55	131	0.420	94.83		
Blue-winged Teal	93	3	28	0.107	5.17	58	0.044
Mallard	54	154	131	1.176	93.33		
Mallard	93	10	28	0.357	6.06		
Mallard	110	1	352	0.003	0.61	165	0.126
Gadwall	54	2	131	0.015	100.00	2	0.002
Great Blue Heron	54	8	131	0.061	100.00	8	0.006
Redhead	54	4	131	0.031	100.00	4	0.003
Canada Goose	54	2	131	0.015	100.00	2	0.002
Killdeer	54	6	131	0.046	35.29		
Killdeer	93	10	28	0.357	58.82		
Killdeer	420	1	6	0.167	5.88	17	0.013
American Coot	54	103	131	0.786	100.00	103	0.079
Common Snipe	20	1	74	0.014	25.00		
Common Snipe	30	3	111	0.027	75.00	4	0.003
Black-crowned Night-heron	54	1	131	0.008	100.00	1	0.001
American White Pelican	54	3	131	0.023	100.00	3	0.002
Double-crested Cormorant	54	10	131	0.076	100.00	10	0.008
Pied-billed Grebe	54	38	131	0.290	100.00	38	0.029
Lesser Yellowlegs	54	1	131	0.008	100.00	1	0.001

(1) Relative abundance

Table 3-11. Waterfowl relative abundance in fall 1998 based on mulit-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Fall	Obs./Min. of Species in Fall
American Wigeon	54	1	96	0.010	100.00	1	0.001
Green-winged Teal	54	24	96	0.250	100.00	24	0.020
Blue-winged Teal	30	2	87	0.023	12.50		
Blue-winged Teal	54	14	96	0.146	87.50	16	0.014
Mallard	54	55	96	0.573	90.16		
Mallard	93	2	2	1.000	3.28		
Mallard	212	4	79	0.051	6.56	61	0.052
Great Blue Heron	54	1	96	0.010	100.00	1	0.001
Ring-necked Duck	54	10	96	0.104	100.00	10	0.009
Bufflehead	54	40	96	0.417	100.00	40	0.034
Common Goldeneye	54	1	96	0.010	100.00	1	0.001
Killdeer	54	1	96	0.010	33.33		
Killdeer	93	2	2	1.000	66.67	3	0.003
American Coot	54	34	96	0.354	100.00	34	0.029
Common Snipe	20	1	88	0.011	100.00	1	0.001
Common Merganser	54	1	96	0.010	100.00	1	0.001
Sora	230	2	164	0.012	100.00	2	0.002
Pied-billed Grebe	54	21	96	0.219	100.00	21	0.018

(1) Relative abundance

Table 3-12. Waterfowl relative abundance in winter 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Winter	Obs./Min. of Species in Winter
Green-winged Teal	54	2	34	0.059	100.00	2	0.002
Mallard	54	50	34	1.471	100.00	50	0.050
Lesser Scaup	54	2	34	0.059	100.00	2	0.002
Redhead	54	15	34	0.441	100.00	15	0.015
Ring-necked Duck	54	14	34	0.412	100.00	14	0.014
Canada Goose	54	4	34	0.118	100.00	4	0.004
Common Goldeneye	54	9	34	0.265	100.00	9	0.009
Common Snipe	20	2	126	0.016	100.00	2	0.002
Hooded Merganser	54	4	34	0.118	100.00	4	0.004
Common Merganser	10	1	34	0.029	50.00		
Common Merganser	54	1	34	0.029	50.00	2	0.002

(1) Relative abundance

Table 3-13. Raptor area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
Spring										
	Redtailed Hawk	BUJA1	2	K	323	2	1	1		
	Redtailed Hawk	BUJA1	2	L	322	1				1
	American Kestrel	FASP1	2	R	322	1	1			
	Northern Harrier	CICY1	4	H	323	1				1
	Great Horned Owl	BUVI1	4	M	110	1				1
	Redtailed Hawk	BUJA1	4	U	110	2	1	1		
	Redtailed Hawk	BUJA1	6	Q	323	1				1
	Rough-legged Hawk	BULA1	7	J	110	1				1
	Turkey Vulture	CAAU1	7	L	322	1				1
	Northern Harrier	CICY1	9	Q	322	1		1		
	American Kestrel	FASP1	10	P	110	1	1			
	Swainson's Hawk	BUSW1	11	L	110	1				1
	Redtailed Hawk	BUJA1	11	M	110	1				1
	Swainson's Hawk	BUSW1	11	M	110/322	2	1	1		2
	Great Horned Owl	BUVI1	11	M	110	3	1	2		
	American Kestrel	FASP1	11	P	110	1	1			
	Redtailed Hawk	BUJA1	12	E	322	1				1
	American Kestrel	FASP1	12	K	322	1	1			
	American Kestrel	FASP1	13	G	322	3	2	1		
	Great Horned Owl	BUVI1	13	S	110	1		1		
	Redtailed Hawk	BUJA1	16	K	110	1				1
	Redtailed Hawk	BUJA1	16	L	230	1				1
Summer										
	Redtailed Hawk	BUJA1	2	F	323	1				1
	American Kestrel	FASP1	2	J	323	1	1			
	Redtailed Hawk	BUJA1	3	N	322	1				1
	Northern Harrier	CICY1	5	I	20	1		1		
	American Kestrel	FASP1	5	P	322	1				1
	Swainson's Hawk	BUSW1	10	Q	323	3				3
	Swainson's Hawk	BUSW1	11	M	110	5			5	
	Swainson's Hawk	BUSW1	12	P	510	1				1
	Redtailed Hawk	BUJA1	14	F	110	2			1	1
	Peregrine Falcon	FAPE1	14	H	20	1				1
	Northern Harrier	CICY1	14	J	230	1		1		

Table 3-13. Raptor area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
Fall	Redtailed Hawk	BUJA1	15	J	323	1				1
	Northern Harrier	CICY1	15	J	230	1		1		
	Redtailed Hawk	BUJA1	2	J	323	1				1
	Redtailed Hawk	BUJA1	2	O	322	1				1
	Northern Harrier	CICY1	2	O	322	1		1		
	Great Horned Owl	BUVI1	3	S	110	1				1
	Great Horned Owl	BUVI1	3	T	324	1				1
	Redtailed Hawk	BUJA1	9	Q	322	1				1
	Redtailed Hawk	BUJA1	10	Q	323	1				1
	Rough-legged Hawk	BULA1	11	H	322	1				1
	Northern Harrier	CICY1	12	E	20	1				1
	Northern Harrier	CICY1	13	G	230	1		1		
	Northern Harrier	CICY1	15	K	20	1			1	
	Redtailed Hawk	BUJA1	16	M	230	3				3
Winter	Redtailed Hawk	BUJA1	4	P	322	1				1
	Rough-legged Hawk	BULA1	5	Q	323	1				1
	Great Horned Owl	BUVI1	5	R	110	1				1
	Rough-legged Hawk	BULA1	7	I	322	1				1
	American Kestrel	FASP1	7	I	322	1	1			
	Great Horned Owl	BUVI1	11	M	110	3				3
	Great Horned Owl	BUVI1	13	G	520	2				2
	Rough-legged Hawk	BULA1	15	I	110	1				1
	Great Horned Owl	BUVI1	15	I	110	1				1
	American Kestrel	FASP1	15	P	322	1				1
	Golden Eagle	AQCH1	15	R	322	1				1

Table 3-14. Raptor relative abundance for 1998 based on multi-species census surveys

Common Name	Total Obs. in 1998	Obs./Min.(1) of Species in 1998
Great Horned Owl	17	0.0036
American Kestrel	5	0.0011
Red-tailed Hawk	3	0.0006
Northern Harrier	2	0.0004
Swainson's Hawk	10	0.0021
Rough-legged Hawk	4	0.0008
Golden Eagle	1	0.0002
Barn Owl	1	0.0002
Ferruginous Hawk	1	0.0002
Short-eared Owl	1	0.0002
Turkey Vulture	1	0.0002

(1) Relative abundance

Table 3-15. Raptor relative abundance in spring 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Spring	Obs./Min. of Species in Spring
Red-tailed Hawk	20	2	120	0.017	33.33		
Red-tailed Hawk	110	3	337	0.009	50.00		
Red-tailed Hawk	322	1	100	0.010	16.67	6	0.005
Ferruginous Hawk	323	1	134	0.007	100.00	1	0.001
Swainson's Hawk	110	2	337	0.006	100.00	2	0.002
Great Horned Owl	110	12	337	0.036	85.71		
Great Horned Owl	230	2	176	0.011	14.29	14	0.011
Turkey Vulture	230	1	176	0.006	100.00	1	0.001
American Kestrel	20	4	120	0.033	40.00		
American Kestrel	110	3	337	0.009	30.00		
American Kestrel	212	2	96	0.021	20.00		
American Kestrel	322	1	100	0.010	10.00	10	0.008

(1) Relative abundance

Table 3-16. Raptor relative abundance in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Summer	Obs./Min. of Species in Summer
Golden Eagle	323	1	170	0.006	100.00	1	0.001
Red-tailed Hawk	30	1	111	0.009	20.00		
Red-tailed Hawk	110	4	352	0.011	80.00	5	0.004
Swainson's Hawk	110	10	352	0.028	100.00	10	0.008
Great Horned Owl	110	4	352	0.011	80.00		
Great Horned Owl	230	1	159	0.006	20.00	5	0.004
Northern Harrier	30	1	111	0.009	33.33		
Northern Harrier	230	1	159	0.006	33.33		
Northern Harrier	323	1	170	0.006	33.33	3	0.002
American Kestrel	110	5	352	0.014	62.50		
American Kestrel	212	1	79	0.013	12.50		
American Kestrel	323	2	170	0.012	25.00	8	0.006

(1) Relative abundance

Table 3-17. Raptor relative abundance in fall 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Fall	Obs./Min. of Species in Fall
Red-tailed Hawk	110	1	310	0.003	20.00		
Red-tailed Hawk	212	3	79	0.038	60.00		
Red-tailed Hawk	230	1	164	0.006	20.00	5	0.004
Rough-legged Hawk	212	1	79	0.013	33.33		
Rough-legged Hawk	230	2	164	0.012	66.67	3	0.003
Great Horned Owl	110	6	310	0.019	85.71		
Great Horned Owl	230	1	164	0.006	14.29	7	0.006
Northern Harrier	20	1	88	0.011	12.50		
Northern Harrier	30	2	87	0.023	25.00		
Northern Harrier	212	3	79	0.038	37.50		
Northern Harrier	230	1	164	0.006	12.50		
Northern Harrier	323	1	138	0.007	12.50	8	0.007
American Kestrel	110	2	310	0.006	22.22		
American Kestrel	212	4	79	0.051	44.44		
American Kestrel	322	1	90	0.011	11.11		
American Kestrel	323	2	138	0.014	22.22	9	0.008
Barn Owl	110	1	310	0.003	100.00	1	0.001

(1) Relative abundance

Table 3-18. Raptor relative abundance in winter 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Percent of Species/Habtype	Total Obs. in Winter	Obs./Min. of Species in Winter
Golden Eagle	322	1	93	0.011	100.00	1	0.001
Short-eared Owl	230	1	137	0.007	100.00	1	0.001
Red-tailed Hawk	110	1	300	0.003	33.33	3	0.003
Red-tailed Hawk	212	2	94	0.021	66.67		
Rough-legged Hawk	20	1	126	0.008	25.00		
Rough-legged Hawk	110	1	300	0.003	25.00		
Rough-legged Hawk	322	1	93	0.011	25.00		
Rough-legged Hawk	323	1	114	0.009	25.00	4	0.004
Great Horned Owl	110	17	300	0.057	100.00	17	0.017
Northern Harrier	110	1	300	0.003	50.00		
Northern Harrier	230	1	137	0.007	50.00	2	0.002
American Kestrel	30	1	49	0.020	20.00		
American Kestrel	110	2	300	0.007	40.00		
American Kestrel	322	2	93	0.022	40.00	5	0.005

(1) Relative abundance

Table 3-19. Frog vocalization index and frequency data summary from 1998 surveys

Index	4/23/98	6/15/98	7/13/98
	Boreal Chorus Frog		
0	3	17	17
1	3	0	0
2	2	0	0
3	9	0	0
	Northern Leopard Frog		
0	16	17	17
1	1	0	0
2	0	0	0
3	0	0	0
	Bullfrog		
0	17	16	16
1	0	1	1
2	0	0	0
3	0	0	0

Numbers represent the number of sites out of 17 that frogs were heard calling at with a given rank.

Table 3-20. Herptile area use in 1998 based on sitewide significant species surveys

Season	Common Name	Species Code	RF Grid N	RF Grid E	Habitat Type	Group Size	Male	Female	Young	Un-Classifed
Spring										
	Boreal Chorus Frog	PSTR1	2	U	54	4	4			
	Boreal Chorus Frog	PSTR1	5	Q	212	10	10			
	Boreal Chorus Frog	PSTR1	5	R	110	5				5
	Boreal Chorus Frog	PSTR1	7	N	49	3	3			
	Boreal Chorus Frog	PSTR1	12	P	54	1	1			
Summer										
	Bullfrog	RACA1	2	U	54	1				1
	Bullfrog	RACA1	2	U	54	1				1
	Prairie Rattlesnake	CRVI1	4	T	420	1				1
	Western Painted Turtle	CHPI1	10	O	54	1				1
	Western Painted Turtle	CHPI1	13	H	54	1				1

Table 3-21. Herptile relative abundance by habitat in 1998 based on multi-species census surveys

Season	Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype
Spring							
	Western Painted	54	16	113	0.142	16	100.000
	Prairie Rattlesnake	322	1	100	0.010	1	100.000
	Boreal Chorus Frog	10	2	46	0.043	94	2.128
	Boreal Chorus Frog	20	6	120	0.050	94	6.383
	Boreal Chorus Frog	30	34	54	0.630	94	36.170
	Boreal Chorus Frog	43	2	3	0.667	94	2.128
	Boreal Chorus Frog	54	30	113	0.265	94	31.915
	Boreal Chorus Frog	110	13	337	0.039	94	13.830
	Boreal Chorus Frog	212	2	96	0.021	94	2.128
	Boreal Chorus Frog	230	5	176	0.028	94	5.319
Summer							
	Western Painted	54	16	131	0.122	18	88.889
	Western Painted	93	2	28	0.071	18	11.111
	Praire Rattlesnake	212	1	79	0.013	1	100.000
	Short-horned lizard	323	2	170	0.012	2	100.000
	Bullfrog	54	3	131	0.023	3	100.000
Fall							
	Western Painted	54	6	96	0.063	6	100.000
	Prairie Rattlesnake	322	1	90	0.011	1	100.000
	Bullfrog	54	1	96	0.010	1	100.000
	Northern Leopard	230	2	164	0.012	2	100.000

(1) Relative abundance

Table 3-22. Special-concern species search list for the Rocky Flats Environmental Technology Site (effective April 20, 1999)

Federal Endangered Species Known to Occur at Rocky Flats

Birds

American Peregrine Falcon (*Falco peregrinus*)[1,2]

Federal Threatened Species Known to Occur at Rocky Flats

Birds

Bald Eagle (*Haliaeetus leucocephalus*)[3]

Mammals

Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*)[4,5,6,7]

Federal Special-Concern Species Known to Occur at Rocky Flats

Reptiles

Eastern Short Horned Lizard (*Phrynosoma douglassii brevirostra*)[5,8]

Birds

Northern Goshawk (*Accipiter gentilis*)[5,8]
Baird's Sparrow (*Ammodramus bairdii*)[5,8]
Western Burrowing Owl (*Athene cunicularia hypugea*)[2,4,5,9]
Ferruginous Hawk (*Buteo regalis*)[4,5,7]
Black Swift (*Cypseliodes niger*)[5,8]
Loggerhead Shrike (*Lanius ludovicianus*)[4,5]
White-faced Ibis (*Plegadis chihi*)[5]

Mammals

Small-footed Myotis (*Myotis subulatus* = *M. ciliolabrum*)[5,8]

Colorado Species of Special Concern Known to Occur at Rocky Flats

Amphibians

Northern Leopard Frog (*Rana pipiens*)[8]

Birds

Long-billed Curlew (*Numenius americanus*)[7,8]
Greater Sandhill Crane (*Grus canadensis tibida*)[8,2]
American White Pelican (*Pelecanus erythrorhynchos*)[4,8]

Federal Endangered Species with Potential Habitat at Rocky Flats

Birds

Whooping Crane (*Grus americana*)
Least Tern (*Sterna antillarum*)
Piping Plover (*Charadrius melodus*)
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)[10]

Mammals

Black-footed Ferret (*Mustela nigripes*)[11]

Table 3-22 (continued)

Federal Threatened Species with Potential Habitat at Rocky Flats

Plants

Ute Ladies'-tresses (*Spiranthes diluvialis*)[12]

Insects

Pawnee Montane Skipper (*Hesperia leonardus montana*)

Federal Proposed Species with Potential Habitat at Rocky Flats

Plants

Colorado Butterfly Plant (*Gaura neomexicana* var. *coloradensis*)[13]

Federal Candidate Species with Potential Habitat at Rocky Flats

Birds

Mountain Plover (*Charadrius montanus*) [14]

Federal Special-Concern Species with Potential Habitat at Rocky Flats

Plants

Bell's Twinpod (*Physaria bellii*)[5]
Tulip Gentian (*Eustoma grandiflora*)[5]
Adder's Mouth Orchid (*Malaxis brachypoda*)[5]

Insects

Regal Fritillary (*Speyeria idalia*)[5]

Fish

Plains Topminnow (*Fundulus sciadicus*)[5]

Birds

Western Snowy Plover (*Charadrius alexandrinus nivosus*)[5]
Black Tern (*Chlidonias niger*)[5]

Mammals

Spotted Bat (*Euderma maculatum*)[5]
Long-eared Myotis (*Myotis evotis*)[5]
Fringed Bat (*Myotis thysanodes*)[5]
Long-legged Myotis (*Myotis volans*)[5]
Pale Townsend's Big-eared Bat (*Plecotus townsendii pallescens*)[5]
Plains Spotted Skunk (*Spilogale putorius interrupta*)[5]
Swift Fox (*Vulpes velox*)[11,5]

Colorado Threatened Species with Potential Habitat at Rocky Flats

Fish

Common Shiner (*Notropis cornutus*)[14]

Colorado Species of Special Concern with Potential Habitat at Rocky Flats

Fish

Stonecat (*Noturus flavus*) [14]

Birds

Barrow's Goldeneye (*Bucephala islandica*) [14]
Plains Sharp-tailed Grouse (*Tympanuchus phasianellus jamesi*)[15]

Table 3-22 (continued)

Watch-Listed Species Known to Occur at Rocky Flats

Reptiles

Red-sided Garter (*Thamnophis sirtalis*)
Western Yellowbelly Racer (*Clouber constrictor*)

Birds

Black-crowned Night-heron (*Nycticorax nycticorax*)[16]
American Bittern (*Botarus lentiginosus*)[16]
Bufflehead (*Bucephala albeola*)[16]
Eared Grebe (*Podoceps nigricollis*)[16]
Sora (*Porzana carolina*)[16]
Cooper's Hawk (*Accipiter cooperii*)[16]
Sharp-shinned Hawk (*Accipiter striatus*)[16]
Golden Eagle (*Aquila chrysaetos*)[16]
Swainson's Hawk (*Buteo swainsoni*)[17]
Northern Harrier (*Circus cyaneus*)[18]
Merlin (*Falco columbarius*)[16]
Prairie Falcon (*Falco mexicanus*)[16]
Short-eared Owl (*Asio flammeus*)[18]
Long-eared Owl (*Asio otus*)[16]
Olive-sided Flycatcher (*Contopus borealis*)[18]
Chestnut-sided Warbler (*Dendroica pensylvanica*)[18]
Virginia's Warbler (*Vermivora virginiae*)[18]
Baird's Sparrow (*Ammodramus bardii*)[18]
Grasshopper Sparrow (*Ammodramus savannarum*)[18]
Lark Bunting (*Calamospiza melanocorys*)[18]
Chestnut-collared Longspur (*Calcarius ornatus*)[18]
Field Sparrow (*Spizella pusilla*)[18]

Mammals

Olive-backed Pocket Mouse (*Perognathus faciatus spp.*)[16]
Plains Pocket Mouse (*Perognathus flavescens*)[16]
Silky Pocket Mouse (*Perognathus flavus*)[16]
Merriam's Shrew (*Sorex merriami*)[16]
Northern Pocket Gopher (*Thomomys talpoides ssp.*)[16]

[1] The species *Falco peregrinus* is listed as endangered wherever found in the conterminous 48 states. Some subspecies are listed separately.

[2] Colorado State threatened species (ST).

[3] The USFWS has down-listed the bald eagle to threatened status.

[4] This species is resident or regularly visits Rocky Flats.

[5] In February 1996, the U. S. Fish and Wildlife Service (USFWS) revised the list of candidate species to include only proposed and C1 species. All former candidate species except C1 species are now classified unofficially as "at-risk" and are still considered special-concern species. The search list includes these species because they may be upgraded to C-1 species at any time.

[6] In May 1998, the USFWS listed the Preble's meadow jumping mouse as a threatened species.

[7] Colorado species of special concern (SC).

[8] The species has been observed infrequently at Rocky Flats.

[9] Listed on August 20, 1997.

[10] Species was listed as a State threatened species May 8, 1998.

Table 3-22 (continued)

[11] This species was previously collected near Rocky Flats.

[12] These species have historically used areas in the vicinity, and suitable feeding or residential habitat exists at Rocky Flats.

[13] Proposed for listing as threatened on March 24, 1998.

[14] Federal candidate species for listing as threatened or endangered.

[15] Colorado State endangered species.

[16] Colorado Natural Heritage Program list of rare and imperiled species.

[17] Species of special interest to the Colorado Division of Wildlife due to recent winter range die-off of the species.

[18] Birds listed by the USFWS as "Migratory Nongame Birds of Management Concern: the 1995 List" that occur at the Site.

Notes:

Candidate, proposed, and listed species lists are under constant revision. As data are reviewed by the USFWS, species are added to and removed from this list on a year-round basis. This list for Rocky Flats Environmental Technology Site is updated annually.

Sources:

Colorado Natural Heritage Program 1996 List of Rare and Imperiled Animals, Plants, and Natural Communities.

Federal Register, February 28, 1996, pp. 7596–7613.

Migratory Nongame Birds of Management Concern in the United States: the 1995 List.

Table 3-23. Bird distribution by habitat based on observations from 1991, 1993-1998 (total number of species = 191)

Species Common Name	Species Scientific Name	Spec Code	Seasonal Abundance Sp	Su	Fa	Wi	Habitats G	D	T	R	W	M	Neotrop Mig (1)	Bree Statt
GREBES	***PODICIPEDIDAE***													
Western Grebe	*Aechmophorus occidentalis*	AEOC1	R		R							X		
Eared Grebe	*Podiceps nigricollis*	PONI1	R		R							X		
Pied-billed Grebe	*Podilymbus podiceps*	POPO1	U	U	U							X		Confirmed
PELICANS	***PELECANIDAE***													
American White Pelican (2)	*Pelecanus erythrorhynchos*	PEER1	O	O								X		
CORMORANTS	***PHALACROCORACIDAE***													
Double-crested Cormorant	*Phalacrocorax auritus*	PHAU1	O	C	O			X				X		
HERONS	***ARDEIDAE***													
Great Blue Heron	*Ardea herodias*	ARHE1	U	C	U		X			X	X	X		
American Bittern	*Botarus lentiginosus*	BOLE1		R								X		
Green-backed Heron	*Butorides striatus*	BUST1	O									X		
Black-crowned Night-heron	*Nycticorax nycticorax*	NYNY1	U	C				X		X	X	X		Confirmed
White-faced Ibis (3)	*Plegadis chihi*	PLCH1		R								X		
GEESE AND DUCKS	***ANATIDAE***													
Wood Duck	*Aix sponsa*	AISP1		R								X		Confirmed
Northern Pintail	*Anas acuta*	ANAC1	O	O								X		
American Wigeon	*Anas americana*	ANAM1	O	O		O						X		
Northern Shoveler	*Anas clypeata*	ANCL1	U	U	U							X		
Green-winged Teal	*Anas crecca*	ANCR1	C	U	O	U						X		
Cinnamon Teal	*Anas cyanoptera*	ANCY1	C	O								X		
Blue-winged Teal	*Anas discors*	ANDI1	C	O	C							X		Confirmed
Mallard	*Anas platyrhynchos*	ANPL1	A	A	C	C	X	X		X	X	X		Confirmed
Gadwall	*Anas strepera*	ANST1	C	U	U							X		Confirmed
Greater Scaup	*Aythya marila*	AYMA1	O		O							X		
Lesser Scaup	*Aythya affinis*	AYAF1	C		U	U						X		
Redhead	*Aythya americana*	AYAM1	U	U		U						X		Confirmed
Ring-necked Duck	*Aythya collaris*	AYCO1	U		U							X		
Canvasback	*Aythya valisineria*	AYVA1				U						X		
Canada Goose	*Branta canadensis*	BRCA1	U	U	U	U	X				X	X		Confirmed
Bufflehead	*Bucephala albeola*	BUAL1	U		C	U		X			X	X		
Common Goldeneye	*Bucephela clangula*	BUCL1	U		U	U						X		
Snow Goose	*Chen caerulescens*	CHCA1			U		X					X		
Hooded Merganser	*Lophodytes cucullatus*	LOCU1	O									X		
Common Merganser	*Mergus merganser*	MEME1	U		O							X		
Ruddy Duck	*Oxyura jamaciensis*	OXJA1	R	R	R							X		Confirmed
AMERICAN VULTURES	***CATHARTIDAE***													
Turkey Vulture	*Cathartes aura*	CAAU1	O	O	O		X	X	X	X	X	X	Yes	
EAGLES AND HAWKS	***ACCIPITRIDAE***													
Cooper's Hawk	*Accipiter cooperii*	ACCO1		R	R		X						Yes	
Northern Goshawk (3)	*Accipiter gentilis*	ACGE1				R	X		X				Yes	
Sharp-shinned Hawk	*Accipiter striatus*	ACST1	U		U		X	X		X	X		Yes	
Golden Eagle	*Aquila chrysaetos*	AQCH1	O	O	O	O	X	X	X	X	X	X	Yes	
Red-tailed Hawk	*Buteo jamaicensis*	BUJA1	C	C	C	C	X	X	X	X	X	X	Yes	Confirmed

Table 3-23. Bird distribution by habitat based on observations from 1991, 1993-1998 (total number of species = 191)

Species Common Name	Species Scientific Name	Spec Code	Seasonal Abundance				Habitats						Neotrop Mig (1)	Breeding Status
			Sp	Su	Fa	Wi	G	D	T	R	W	M		
Rough-legged Hawk	*Buteo lagopus*	BULA1	O		C	C	X	X	X	X	X	X		
Ferruginous Hawk (2,3)	*Buteo regalis*	BURE1	U	U	U	U	X	X	X	X	X	X	Yes	
Swainson's Hawk	*Buteo swainsoni*	BUSW1	U	U	O		X		X	X	X	X	Yes	Confirmed
Northern Harrier	*Circus cyaneus*	CICY1	O	U	O	U	X	X	X	X	X	X	Yes	Suspected
Bald Eagle (4)	*Haliaeetus lecocephalus*	HALE1			O	O	X		X			X		
Osprey	*Pandion haliaetus*	PAHA1		R	R							X		
FALCONS	***FALCONIDAE***													
Merlin	*Falco columbarius*	FACO1	R			R				X	X		Yes	
Prairie Falcon	*Falco mexicanus*	FAME1	O		O	O	X	X	X	X	X		Yes	
Peregrine Falcon (4)	*Falco peregrinus*	FAPE1	R		R	R	X		X	X	X		Yes	
American Kestrel	*Falco sparverius*	FASP1	O	U	U	O	X	X	X	X	X	X	Yes	Confirmed
GROUSE AND TURKEYS	***PHASIANIDAE***													
Wild Turkey	*Meleagris gallopavo*	MEGA1	R				X							
Ring-necked Pheasant	*Phasianus colchicus*	PHCO1	U	U	U	U	X			X	X	X		Suspected
RAILS AND COOTS	***RALLIDAE***													
American Coot	*Fulica americana*	FUAM1	U	U	U		X			X	X			Confirmed
Sora	*Porzana carolina*	POCA1		U								X		Suspected
Virginia Rail	*Rallus limicola*	RALI1	U									X		Suspected
CRANES	***GRUIDAE***													
Sandhill Crane (2)	*Grus canadensis*	GRCA1			O		X					X		
PLOVERS	***CHARADRIIDAE***													
Killdeer	*Charadrius vociferus*	CHVO1	C	C	U		X	X		X	X	X		Confirmed
STILTS AND AVOCETS	***RECURVIROSTRIDAE***													
American Avocet	*Recurvirostra americana*	REAM1	U									X		
SANDPIPERS AND ALLIES	***SCOLOPACIDAE***													
Spotted Sandpiper	*Actitis macularia*	ACMA1	C	U								X		
Pectoral Sandpiper	*Calidris melanotos*	CAME1	O	O								X		
Semipalmated Sandpiper	*Calidris pusilla*	CAPU1	R									X		
Willet	*Catoptrophorus semipalmatus*	CASE1	U	O								X		
Common Snipe	*Gallinago gallinago*	GAGA1	U	C	U					X	X	X		Confirmed
Long-billed Dowitcher	*Limnodromus scolopaceus*	LISC1	O									X		
Long-billed Curlew (2)	*Numenius americanus*	NUAM1	R			R	X	X					Yes	
Wilson's Phalarope	*Phalaropus tricolor*	PHTR1	U									X		
Lesser Yellowlegs	*Tringa flavipes*	TRFL1	O	O								X		
Greater Yellowlegs	*Tringa melanoleuca*	TRME1		R								X		
Solitary Sandpiper	*Tringa solitaria*	TRSO1	U	O								X		
GULLS	***LARIDAE***													
Ring-billed Gull	*Larus delawarensis*	LADE1	C	O	O	O	X		X	X		X		
Franklin's Gull	*Larus pipixcan*	LAPI1			O		X					X		
PIGEONS AND DOVES	***COLUMBIDAE***													
Band-tailed Pigeon	*Columba fasciata*	COFA1		O			X						Yes	Confirmed
Rock Dove	*Columba livia*	COLI1	C	C	C	C	X	X		X	X	X		Confirmed
Mourning Dove	*Zenaida macroura*	ZEMA1	C	C	C		X	X	X	X	X	X		Confirmed

Table 3-23. Bird distribution by habitat based on observations from 1991, 1993-1998 (total number of species = 191)

Species Common Name	Species Scientific Name	Spec Code	Seasonal Abundance Sp	Su	Fa	Wi	Habitats G	D	T	R	W	M	Neotrop Mig (1)	Breed Status
CUCKOOS	*CUCULIDAE*													
Black-billed Cuckoo+A67	*Coccyzus erythropthalmus*	COER1		R							X		Yes	
OWLS	*STRIGIDAE*													
Short-eared Owl	*Asio flammeus*	ASFL1	O	O	O	O	X		X	X	X		Yes	
Long-eared Owl	*Asio otus*	ASOT1	O	O	O				X	X	X		Yes	
Burrowing Owl (5)	*Athene cunicularia*	ATCU1	R	R			X						Yes	
Great Horned Owl	*Bubo virginianus*	BUVI1	C	C	C	C	X	X	X	X	X	X		Confirmed
Barn Owl*	*Tyto alba*	TYAL1			R						X			
NIGHT JARS	*CAPRIMULGIDAE*													
Common Nighthawk	*Chordeiles minor*	CHMI1	U	U			X	X	X		X	X	Yes	Confirmed
Common Poorwill	*Phalaenoptilus nuttallii*	PHNU1		C			X		X				Yes	
SWIFTS	*APODIDAE*													
Black Swift (3)	*Cypseloides niger*	CYNI1	R				X						Yes	
HUMMINGBIRDS	*TROCHILIDAE*													
Broad-tailed Hummingbird	*Selasphorus platycercus*	SEPL1		O			X	X	X		X		Yes	Suspected
Rufous Hummingbird	*Selasphorus rufus*	SERU1		O						X			Yes	
KINGFISHERS	*ALCEDINIDAE*													
Belted Kingfisher	*Ceryle alcyon*	CEAL1	O	O	O						X	X	Yes	
WOODPECKERS	*PICIDAE*													
Northern Flicker	*Colaptes auratus*	COAU1	U	U	C	C	X	X	X	X	X			Suspected
Downy Woodpecker	*Picoides pubescens*	PIPU1		O	O	O			X	X	X			Suspected
Hairy Woodpecker	*Picoides villosus*	PIVI1			O				X	X	X			
Red-naped Sapsucker	*Sphyrapicus nuchalis*	SPNU1			O						X		Yes	
TYRANT FLYCATCHERS	*TYRANNIDAE*													
Olive-sided Flycatcher	*Contopus borealis*	COBO1			O						X		Yes	
Western Wood-Pewee	*Contopus sordidulus*	COSO1	U	U	O		X		X	X	X		Yes	
Hammond's Flycatcher	*Empidonax hammondii*	EMHA1	U								X		Yes	
Dusky Flycatcher	*Empidonax obserholseri*	EMOB1	U		O						X	X	Yes	
Cordilleran Flycatcher	*Empidonax occidentails*	EMDI1	U		O				X		X	X	Yes	
Willow Flycatcher	*Empidonax traillii*	EMTR1	U								X		Yes	
Ash-throated Flycatcher	*Myiarchus cinerascens*	MYCI1	R						X				Yes	
Eastern Phoebe	*Sayornis phoebe*	SAPH1	R								X		Yes	
Say's Phoebe	*Sayornis saya*	SASA1	C	C	U		X	X	X	X	X	X	Yes	Confirmed
Scissor-tailed Flycatcher	*Tyrannus forficatus*	TYFO1	R				X						Yes	
Eastern Kingbird	*Tyrannus tyrannus*	TYTY1	O	C			X		X	X	X	X	Yes	Confirmed
Western Kingbird	*Tyrannus verticalis*	TYVE1	C	C	U		X	X	X	X	X	X	Yes	Confirmed
LARKS	*ALAUDIDAE*													
Horned Lark	*Eremophila alpestris*	ERAL1	U	O	U	C	X	X	X		X	X	Yes	Confirmed
SWALLOWS	*HIRUNDINIDAE*													
Cliff Swallow	*Hirundo pyrrhonota*	HIPY1	U	C	U		X	X	X	X	X	X	Yes	Confirmed
Barn Swallow	*Hirundo rustica*	HIRU1	C	A	U		X	X	X	X	X	X	Yes	Confirmed
Northern Rough-winged Swallow	*Steigidopteryx serripennis*	STSE1	O				X				X		Yes	
Tree Swallow	*Tachycineta bicolor*	TABI1	C	C	O		X		X	X	X	X	Yes	Suspected
Violet-green Swallow	*Tachycineta thalassina*	TATH1	U	U			X		X	X	X	X	Yes	Suspected

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Species Common Name	Species Scientific Name	Spec Code	Seasonal Abundance				Habitats						Neotrop Mig (1)	Breeding Status
			Sp	Su	Fa	Wi	G	D	T	R	W	M		
CROWS, JAYS, MAGPIES	***CORVIDAE***													
American Crow	*Corvus brachyrhynchos*	COBR1	O	O	O	O	X		X			X		
Common Raven	*Corvus corax*	COCO1	U	O	O	U	X	X	X	X	X	X		Confirmed
Blue Jay	*Cyanocitta cristata*	CYCR1		U	U		X		X	X	X	X		
Pinyon Jay	*Gymnorhinus cyanocephalus*	GYCY1		O							X			
Black-billed Magpie	*Pica pica*	PIPI1	C	C	C	C	X	X	X	X	X	X		Confirmed
TITMICE	***PARIDAE***													
Black-capped Chickadee	*Parus atricapillus*	PAAT1	O	O	O	O			X	X	X			Confirmed
Mountain Chickadee	*Parus gambei*	PAGA1	R								X			
NUTHATCHES	***SITTIDAE***													
Red-breasted Nuthatch	*Sitta canadensis*	SICA2			R						X			
White-breasted Nuthatch	*Sitta carolinensis*	SICA1	U								X			
WRENS	***TROGLODYTIDAE***													
Marsh Wren	*Cistothorus palustris*	CIPA1	U	U	U			X				X	Yes	Suspected
Rock Wren	*Salpinctes obsoletus*	SAOB1	C	C	U		X	X			X	X		
House Wren	*Troglodytes aedon*	TRAE1	U	O	O		X		X	X	X		Yes	Suspected
Winter Wren	*Troglodytes troglodytes*	TRTR1			R					X				
MUSCICAPIDS	***MUSCICAPIDAE***													
Hermit Thrush	*Catharus guttatus*	CAGU1	U						X	X	X		Yes	
Swainson's Thrush	*Catharus ustulatus*	CAUS1		U					X	X			Yes	
Townsend's Solitaire	*Myadestes townsendi*	MYTO1	U			O					X	X	Yes	
Blue-gray Gnatcatcher	*Polioptila caerulea*	POCA2	U		R				X	X	X		Yes	Confirmed
Ruby-crowned Kinglet	*Regulus calendula*	RECA1			C						X		Yes	Suspected
Golden-crowned Kinglet	*Regulus satrapa*	RESA1		R					X	X	X			
Mountain Bluebird	*Sialia currucoides*	SICU1	U		U		X		X				Yes	
Western Bluebird	*Sialia mexicana*	SIME1	R								X		Yes	
American Robin	*Turdus migratorius*	TUMI1	C	C	U	O	X	X	X	X	X	X	Yes	Confirmed
THRASHERS	***MIMIDAE***													
Gray Catbird	*Dumetella carolinensis*	DUCA1	U	U						X			Yes	Suspected
Northern Mockingbird	*Mimus polyglottos*	MIPO1	R	R	R		X			X	X			Suspected
Sage Thrasher	*Oreoscoptes montanus*	ORMO1	U	U	U		X	X	X	X	X		Yes	Suspected
Brown Thrasher	*Toxostoma rufum*	TORU1		R					X					
PIPITS	***MOTACILLIDAE***													
American Pipit	*Anthus rubescens*	ANRU1	U		U		X			X			Yes	
WAXWINGS	***BOMBYCILLIDAE***													
Bohemian Waxwing	*Bombycilla garrulus*	BOGA1				U			X					
SHRIKES	***LANIIDAE***													
Northern Shrike	*Lanius excubitor*	LAEX1				O				X				
Loggerhead Shrike (3)	*Lanius ludovicianus*	LALU1	U	O	O	O	X	X	X	X	X	X	Yes	Suspected
STARLINGS	***STURNIDAE***													
European Starling	*Sturnus vulgaris*	STVU1	C	A	C	U	X	X	X	X	X	X		Confirmed
VIREOS	***VIREONIDAE***													
Warbling Vireo	*Vireo gilvus*	VEGI1	U	U						X			Yes	Suspected
Solitary Vireo	*Vireo solitarius*	VISO1			O					X			Yes	

Table 3-23. Bird distribution by habitat based on observations from 1991, 1993-1998 (total number of species = 191)

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			Sp	Su	Fa	Wi	G	D	T	R	W	M		
WOOD WARBLERS	***EMBERIZIDAE: Parulinae***													
Yellow-rumped Warbler	*Dendroica coronata*	DECO1	C	O	C				X	X	X		Yes	
Black-throated Gray Warbler	*Dendroica nigrescens*	DENI1				R			X		X		Yes	
Palm Warbler	*Dendroica palmarum*	DEPA1			R		X					X	Yes	
Chestnut-sided Warbler	*Dendroica pensylvanica*	DEPE2		R					X				Yes	Suspected
Yellow Warbler	*Dendroica petechia*	DEPE1	C	C	C		X		X	X	X	X	Yes	Confirmed
Townsend's Warbler	*Dendroica townsendi*	DETO1			O							X	Yes	
Common Yellowthroat	*Geothlypis trichas*	GETR1	U	C	C		X		X	X	X	X	Yes	Confirmed
Yellow-breasted Chat	*Icteria virens*	ICVI1	U						X		X		Yes	Suspected
MacGillivray's Warbler	*Oporonis tolmiei*	OPTO1			U		X		X	X	X	X	Yes	
Ovenbird	*Seiurus aurocapillus*	SEAU1	R						X		X		Yes	
American Redstart	*Setophaga ruticilla*	SERU2	R						X				Yes	
Virginia's Warbler	*Vermivora virginiae*	VEVI1			R						X		Yes	
Wilson's Warbler	*Wilsonia pusilla*	WIPU1			U				X	X	X	X	Yes	
TANAGERS	***EMBERIZIDAE: Thraupinae***													
Western Tanager	*Piranga ludoviciana*	PILU1	U		U						X		Yes	
GROSBEAKS AND ALLIES	***EMBERIZIDAE: Cardinalinae***													
Blue Grosbeak	*Guiraca caerulea*	GUCA1	U	C	U		X		X	X	X		Yes	Confirmed
Lazuli Bunting	*Passerina amoena*	PAAM1	O	O					X		X		Yes	
Indigo Bunting	*Passerina cyanea*	PACY1	O	O							X		Yes	
Black-headed Grosbeak	*Pheucticus melanocephalus*	PHME1			O						X		Yes	
TOWHEES AND SPARROWS	***EMBERIZIDAE: Emberizinae***													
Baird's Sparrow (3)	*Ammodramus bairdii*	AMBA1	R		R		X		X				Yes	
Grasshopper Sparrow	*Ammodramus savannarum*	AMSA1	C	C	U		X	X	X	X		X	Yes	Confirmed
Lark Bunting	*Calamospiza melanocorys*	CAME3	O	O	O		X	X					Yes	
Lapland Longspur	*Calcarius lapponicus*	CALA1				O	X							
Chestnut-collared Longspur	*Calcarius ornatus*	CAOR1				R	X						Yes	
Snow Bunting	*Plectrophenax nivalis*	PLNI1			R	R	X							
Lark Sparrow	*Chondestes grammacus*	CHGR1		O	O				X			X	Yes	Suspected
Dark-eyed Junco	*Junco hyemalis*	JUHY1	U	U	U	O	X		X	X	X	X	Yes	Suspected
Lincoln's Sparrow	*Melospiza lincolnii*	MELI1	U		U						X	X	Yes	
Fox Sparrow	*Passerella iliaca*	PAIL1			R				X					
Song Sparrow	*Melospiza melodia*	MEME2	C	C	C	U	X	X	X	X	X	X		Confirmed
Savannah Sparrow	*Passerculus sandwichensis*	PASA1	U	U	U		X	X	X	X	X	X	Yes	Suspected
Green-tailed Towhee	*Pipilo chlorurus*	PICH1	U	U	O				X	X	X		Yes	Suspected
Rufous-sided Towhee	*Pipilo erythrophthalmus*	PIER1	C	C	C	O	X	X	X	X	X	X	Yes	Confirmed
Vesper Sparrow	*Pooecetes gramineus*	POGR1	A	A	C		X	X	X	X	X	X	Yes	Confirmed
American Tree Sparrow	*Spizella arborea*	SPAR1	U		U	C	X	X	X	X	X	X		
Brewer's Sparrow	*Spizella breweri*	SPBR1		U	C		X		X		X	X	Yes	
Field Sparrow	*Spizella pusilla*	SPPU1		R						X				
Clay-colored Sparrow	*Spizella pallida*	SPPA2			U	U	X		X		X	X	Yes	
Chipping Sparrow	*Spizella passerina*	SPPA1	U	U	C	O	X	X	X	X	X	X	Yes	
White-crowned Sparrow	*Zonotrichia leucophrys*	ZOLE1	C		C		X		X	X	X			
Harris' Sparrow	*Zonotrichia querula*	ZOQU1				R					X			

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MEADOWLARKS, BLACKBIRDS	***EMBERIZIDAE: Icterinae***													
Red-winged Blackbird	*Agelaius phoeniceus*	AGPH1	A	A	C	U	X	X	X	X	X	X	Yes	Confirmed
Brewer's Blackbird	*Euphagus cyanocephalus*	EUCY1	C	U	O		X	X	X	X	X	X	Yes	Confirmed
Northern Oriole	*Icterus galbula*	ICGA1	C	C			X		X	X	X	X	Yes	Confirmed
Brown-headed Cowbird	*Molothrus ater*	MOAT1	U	C			X		X	X	X	X	Yes	Suspected
Common Grackle	*Quiscalus quiscula*	QUQU1	U	C	O		X	X		X	X	X		Confirmed
Western Meadowlark	*Sturnella neglecta*	STNE1	A	A	A	O	X	X	X	X	X	X	Yes	Confirmed
Yellow-headed Blackbird	*Xanthocephalus xanthocephalu*	XAXA1	C	C							X	X	Yes	Confirmed
FINCHES	***FRINGILLIDAE***													
Pine Siskin	*Carduelis pinus*	CAPI1	U	O	O	O	X		X	X	X	X	Yes	
Lesser Goldfinch	*Carduelis psaltria*	CAPS1	O	U	O		X	X	X	X	X		Yes	Suspected
American Goldfinch	*Carduelis tristis*	CATR1	C	A	C	O	X	X	X	X	X	X	Yes	Confirmed
Cassin's Finch	*Carpodacus cassinii*	CACA2	R							X			Yes	
House Finch	*Carpodacus mexicanus*	CAME2	A	A	A	U	X	X	X	X	X	X		Confirmed
OLD WORLD SPARROWS	***PASSERIDAE***													
House Sparrow	*Passer domesticus*	PADO1	C	C	C	C	X	X			X			Confirmed

DEFINITIONS

SEASONS
Sp = Spring
Su = Summer
Fa = Fall
Wi = Winter

HABITATS
G = Grassland
D = Disturbed
T = Tall Upland Shrubland
R = Riparian Shrubland
W = Woodland
M = Marshland

RELATIVE ABUNDANCE
(In appropriate habitat for species)
A = Abundant
C = Common
U = Uncommon
O = Occasional
R = Rare at the Site

NOTE

Taxonomic organization of table follows "Colorado Birds: A reference to their distribution and habitat," Andrews & Righter, 1992.
(1) Neotropical Migrants are a migratory bird group of concern due to significant population declines over two continents.
(2) A Colorado Species of Special Concern
(3) Federal special-concern species
(4) Federal threatened or endangered species
(5) State threatened species
*New species for 1998

Table 3-24. Migratory bird relative abundance sitewide 1998 based on multi-species census surveys

Common Name	Total Observed	Obs./Min.in 1988 (1)	Common Name	Total Observed	Obs./Min.in 1988 (1)
European Starling	798	0.168	Lark Sparrow	30	0.006
Red-winged Blackbird	705	0.149	Horned Lark	28	0.006
House Finch	644	0.136	Chestnut-collared longspur	24	0.005
Western Meadowlark	490	0.103	House Wren	21	0.004
Vesper Sparrow	440	0.093	Lesser Goldfinch	15	0.003
Song Sparrow	207	0.044	Yellow-rumped Warbler	14	0.003
Barn Swallow	189	0.040	Common Raven	12	0.003
American Goldfinch	176	0.037	Eastern Phoebe	12	0.003
American Robin	156	0.033	Yellow-breasted Chat	9	0.002
Black-billed Magpie	154	0.032	Sage Thrasher	8	0.002
Mourning Dove	144	0.030	Rock Dove	7	0.002
Grasshopper Sparrow	127	0.027	Broad-tailed Hummingbird	7	0.001
Rufous-sided Towhee	114	0.024	Green-tailed Towhee	7	0.001
American Tree Sparrow	108	0.023	Downy Woodpecker	5	0.001
White-crowned Sparrow	105	0.022	Dark-eyed Junco	4	0.001
Pine Siskin	95	0.020	Eastern Kingbird	4	0.001
Northern Oriole	76	0.016	Common Nighthawk	4	0.001
Common Yellowthroat	73	0.015	Western Wood-Pewee	3	0.001
Yellow-headed Blackbird	71	0.015	Blue Jay	2	0.000
Black-capped Chickadee	69	0.015	Chestnut-sided warbler	2	0.000
Cliff Swallow	68	0.014	Common Grackle	2	0.000
Mountain Bluebird	60	0.013	Marsh Wren	2	0.000
Northern Flicker	58	0.012	Black-headed Grosbeak	1	0.000
Yellow Warbler	55	0.012	Northern Mockingbird	1	0.000
Blue Grosbeak	51	0.011	Northern Shrike	1	0.000
Brewer's Blackbird	49	0.010	Rock Wren	1	0.000
Western Kingbird	47	0.010	Savannah Sparrow	1	0.000
Brown-headed Cowbird	39	0.008	Western Bluebird	1	0.000
Say's Phoebe	33	0.007	Western Tanager	1	0.000
Chipping Sparrow	31	0.007			

(1) Relative abundance

Table 3-25. Migratory bird relative abundance Sitewide in Spring 1998 based in multi-species census surveys

Common Name	Total Observed	Obs./Min. in Spring (1)	Common Name	Total Observed	Obs./Min. in Spring (1)
Western Meadowlark	268	0.213	Common Raven	7	0.006
Red-winged Blackbird	239	0.190	Yellow-breasted Chat	6	0.005
European Starling	226	0.180	Horned Lark	5	0.004
House Finch	110	0.087	Blue Grosbeak	5	0.004
Vesper Sparrow	91	0.072	Chipping Sparrow	4	0.003
Song Sparrow	78	0.062	Broad-tailed Hummingbird	3	0.002
American Robin	61	0.048	American Tree Sparrow	3	0.002
Mountain Bluebird	60	0.048	Green-tailed Towhee	2	0.002
Mourning Dove	48	0.038	Western Tanager	1	0.001
Rufous-sided Towhee	45	0.036	Western Bluebird	1	0.001
American Goldfinch	45	0.036	Savannah Sparrow	1	0.001
Northern Oriole	29	0.023	Rock Wren	1	0.001
Brown-headed Cowbird	29	0.023	Marsh Wren	1	0.001
Black-billed Magpie	22	0.017	House Wren	1	0.001
Yellow Warbler	21	0.017	Eastern Kingbird	1	0.001
Cliff Swallow	18	0.014	Dark-eyed Junco	1	0.001
Grasshopper Sparrow	15	0.012	Common Nighthawk	1	0.001
Common Yellowthroat	15	0.012	Common Grackle	1	0.001
Yellow-rumped Warbler	14	0.011	Chestnut-sided warbler	1	0.001
Barn Swallow	13	0.010	Blue Jay	1	0.001
Brewer's Blackbird	12	0.010			
Black-capped Chickadee	12	0.010			
White-crowned Sparrow	10	0.008			
Western Kingbird	8	0.006			
Northern Flicker	8	0.006			
Yellow-headed Blackbird	7	0.006			
Say's Phoebe	7	0.006			
Rock Dove	7	0.006			

(1) Relative abundance

Table 3-26. Migratory bird relative abundance by habitat in spring 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/ Habtype	Total Observed	Obs./Min. in Spring
Red-winged Blackbird	10	10	46	0.217	239	4.18		
Red-winged Blackbird	20	93	120	0.775	239	38.91		
Red-winged Blackbird	30	69	54	1.278	239	28.87		
Red-winged Blackbird	54	4	113	0.035	239	1.67		
Red-winged Blackbird	93	7	21	0.333	239	2.93		
Red-winged Blackbird	110	24	337	0.071	239	10.04		
Red-winged Blackbird	211	2	30	0.067	239	0.84		
Red-winged Blackbird	212	10	96	0.104	239	4.18		
Red-winged Blackbird	230	17	176	0.097	239	7.11		
Red-winged Blackbird	322	3	100	0.030	239	1.26	239	0.1898
Grasshopper Sparrow	10	1	46	0.022	15	6.67		
Grasshopper Sparrow	20	2	120	0.017	15	13.33		
Grasshopper Sparrow	211	1	30	0.033	15	6.67		
Grasshopper Sparrow	212	1	96	0.010	15	6.67		
Grasshopper Sparrow	322	4	100	0.040	15	26.67		
Grasshopper Sparrow	323	6	134	0.045	15	40.00	15	0.0119
House Finch	110	69	337	0.205	110	62.73		
House Finch	211	2	30	0.067	110	1.82		
House Finch	212	4	96	0.042	110	3.64		
House Finch	230	10	176	0.057	110	9.09		
House Finch	322	16	100	0.160	110	14.55		
House Finch	323	1	134	0.007	110	0.91		
House Finch	324	8	24	0.333	110	7.27	110	0.0874
American Goldfinch	110	18	337	0.053	45	40.00		
American Goldfinch	212	4	96	0.042	45	8.89		
American Goldfinch	230	23	176	0.131	45	51.11	45	0.0357
Common Nighthawk	323	1	134	0.007	1	100.00	1	0.0008
Marsh Wren	30	2	54	0.037	2	100.00	1	0.0008
Northern Flicker	20	1	120	0.008	8	12.50		
Northern Flicker	110	7	337	0.021	8	87.50	8	0.0064
Common Raven	110	1	337	0.003	7	14.29		
Common Raven	324	6	24	0.250	7	85.71	7	0.0056
Rock Dove	20	7	120	0.058	7	100.00	7	0.0056
Blue Jay	230	2	176	0.011	2	100.00	1	0.0008
Yellow-rumped Warbler	110	12	337	0.036	14	85.71		
Yellow-rumped Warbler	230	1	176	0.006	14	7.14		
Yellow-rumped Warbler	530	1	5	0.200	14	7.14	14	0.0111
Yellow Warbler	110	19	337	0.056	21	90.48		
Yellow Warbler	212	1	96	0.010	21	4.76		
Yellow Warbler	230	1	176	0.006	21	4.76	21	0.0167
Chestnut-sided warbler	230	1	176	0.006	1	100.00	1	0.0008
Horned Lark	323	5	134	0.037	5	100.00	5	0.0040
Brewer's Blackbird	10	2	46	0.043	12	16.67		
Brewer's Blackbird	93	4	21	0.190	12	33.33		
Brewer's Blackbird	110	5	337	0.015	12	41.67		
Brewer's Blackbird	230	1	176	0.006	12	8.33	12	0.0095
Common Yellowthroat	10	1	46	0.022	15	6.67		
Common Yellowthroat	20	3	120	0.025	15	20.00		
Common Yellowthroat	30	6	54	0.111	15	40.00		
Common Yellowthroat	110	3	337	0.009	15	20.00		

Table 3-26. Migratory bird relative abundance by habitat in spring 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (i)	Total # Obs for Species	Percent of Species/ Habtype	Total Observed	Obs./Min. in Spring
Common Yellowthroat	230	2	176	0.011	15	13.33	15	0.0119
Blue Grosbeak	110	2	337	0.006	5	40.00		
Blue Grosbeak	212	2	96	0.021	5	40.00		
Blue Grosbeak	230	1	176	0.006	5	20.00	5	0.0040
Cliff Swallow	230	18	176	0.102	18	100.00	18	0.0143
Barn Swallow	20	1	120	0.008	13	7.69		
Barn Swallow	30	3	54	0.056	13	23.08		
Barn Swallow	110	3	337	0.009	13	23.08		
Barn Swallow	230	4	176	0.023	13	30.77		
Barn Swallow	324	2	24	0.083	13	15.38	13	0.0103
Northern Oriole	20	1	120	0.008	29	3.45		
Northern Oriole	110	19	337	0.056	29	65.52		
Northern Oriole	212	6	96	0.063	29	20.69		
Northern Oriole	230	3	176	0.017	29	10.34	29	0.0230
Yellow-breasted Chat	230	6	176	0.034	6	100.00	6	0.0048
Dark-eyed Junco	110	1	337	0.003	1	100.00	1	0.0008
Song Sparrow	20	13	120	0.108	78	16.67		
Song Sparrow	30	8	54	0.148	78	10.26		
Song Sparrow	110	21	337	0.062	78	26.92		
Song Sparrow	211	1	30	0.033	78	1.28		
Song Sparrow	212	5	96	0.052	78	6.41		
Song Sparrow	230	30	176	0.170	78	38.46	78	0.0620
Brown-headed Cowbird	10	3	46	0.065	29	10.34		
Brown-headed Cowbird	20	1	120	0.008	29	3.45		
Brown-headed Cowbird	110	5	337	0.015	29	17.24		
Brown-headed Cowbird	230	20	176	0.114	29	68.97	29	0.0230
Black-capped Chickadee	110	3	337	0.009	12	25.00		
Black-capped Chickadee	230	9	176	0.051	12	75.00	12	0.0095
Savannah Sparrow	20	1	120	0.008	1	100.00	1	0.0008
Green-tailed Towhee	110	1	337	0.003	2	50.00		
Green-tailed Towhee	230	1	176	0.006	2	50.00	2	0.0016
Rufous-sided Towhee	230	45	176	0.256	45	100.00	45	0.0357
Western Tanager	230	1	176	0.006	1	100.00	1	0.0008
Black-billed Magpie	20	1	120	0.008	22	4.55		
Black-billed Magpie	110	9	337	0.027	22	40.91		
Black-billed Magpie	230	12	176	0.068	22	54.55	22	0.0175
Vesper Sparrow	10	3	46	0.065	91	3.30		
Vesper Sparrow	20	7	120	0.058	91	7.69		
Vesper Sparrow	30	1	54	0.019	91	1.10		
Vesper Sparrow	110	10	337	0.030	91	10.99		
Vesper Sparrow	211	4	30	0.133	91	4.40		
Vesper Sparrow	212	3	96	0.031	91	3.30		
Vesper Sparrow	230	4	176	0.023	91	4.40		
Vesper Sparrow	322	13	100	0.130	91	14.29		
Vesper Sparrow	323	40	134	0.299	91	43.96		
Vesper Sparrow	324	5	24	0.208	91	5.49		
Vesper Sparrow	420	1	3	0.333	91	1.10	91	0.0723
Common Grackle	212	1	96	0.010	1	100.00	1	0.0008
Rock Wren	530	1	5	0.200	1	100.00	1	0.0008
Say's Phoebe	20	2	120	0.017	7	28.57		

Table 3-26. Migratory bird relative abundance by habitat in spring 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/ Habtype	Total Observed	Obs./Min. in Spring
Say's Phoebe	110	2	337	0.006	7	28.57		
Say's Phoebe	212	1	96	0.010	7	14.29		
Say's Phoebe	324	2	24	0.083	7	28.57	7	0.0056
Broad-tailed Hummingbird	110	2	337	0.006	3	66.67		
Broad-tailed Hummingbird	230	1	176	0.006	3	33.33	3	0.0024
Mountain Bluebird	10	1	46	0.022	60	1.67		
Mountain Bluebird	110	54	337	0.160	60	90.00		
Mountain Bluebird	230	5	176	0.028	60	8.33	60	0.0477
Western Bluebird	110	1	337	0.003	1	100.00	1	0.0008
American Tree Sparrow	110	2	337	0.006	3	66.67		
American Tree Sparrow	322	1	100	0.010	3	33.33	3	0.0024
Chipping Sparrow	230	4	176	0.023	4	100.00	4	0.0032
Western Meadowlark	10	4	46	0.087	268	1.49		
Western Meadowlark	20	30	120	0.250	268	11.19		
Western Meadowlark	30	8	54	0.148	268	2.99		
Western Meadowlark	110	75	337	0.223	268	27.99		
Western Meadowlark	211	12	30	0.400	268	4.48		
Western Meadowlark	212	17	96	0.177	268	6.34		
Western Meadowlark	230	23	176	0.131	268	8.58		
Western Meadowlark	322	39	100	0.390	268	14.55		
Western Meadowlark	323	46	134	0.343	268	17.16		
Western Meadowlark	324	13	24	0.542	268	4.85		
Western Meadowlark	420	1	3	0.333	268	0.37	268	0.2129
European Starling	20	9	120	0.075	226	3.98		
European Starling	110	197	337	0.585	226	87.17		
European Starling	212	1	96	0.010	226	0.44		
European Starling	322	4	100	0.040	226	1.77		
European Starling	324	15	24	0.625	226	6.64	226	0.1795
House Wren	230	2	176	0.011	2	100.00	1	0.0008
American Robin	20	3	120	0.025	61	4.92		
American Robin	110	33	337	0.098	61	54.10		
American Robin	212	2	96	0.021	61	3.28		
American Robin	230	20	176	0.114	61	32.79		
American Robin	322	1	100	0.010	61	1.64		
American Robin	324	2	24	0.083	61	3.28	61	0.0485
Eastern Kingbird	110	1	337	0.003	1	100.00	1	0.0008
Western Kingbird	110	8	337	0.024	8	100.00	8	0.0064
Yellow-headed Blackbird	30	7	54	0.130	7	100.00	7	0.0056
Mourning Dove	20	4	120	0.033	48	8.33		
Mourning Dove	30	4	54	0.074	48	8.33		
Mourning Dove	110	38	337	0.113	48	79.17		
Mourning Dove	230	1	176	0.006	48	2.08		
Mourning Dove	323	1	134	0.007	48	2.08	48	0.0381
White-crowned Sparrow	110	6	337	0.018	10	60.00		
White-crowned Sparrow	211	2	30	0.067	10	20.00		
White-crowned Sparrow	230	2	176	0.011	10	20.00	10	0.0079

(1) Relative abundance

Table 3-27. Migratory bird relative abundance sitewide in summer 1998 based on multi-species census surveys

Common Name	Total Observed	Obs./Min. in Summer (1)	Common Name	Total Observed	Obs./Min. in Summer (1)
European Starling	500	0.383	Black-capped Chickadee	14	0.011
Red-winged Blackbird	422	0.323	Brown-headed Cowbird	10	0.008
House Finch	369	0.283	Eastern Phoebe	9	0.007
Vesper Sparrow	202	0.155	Sage Thrasher	7	0.005
Barn Swallow	149	0.114	Northern Flicker	5	0.004
Western Meadowlark	147	0.113	Broad-tailed Hummingbird	4	0.003
American Goldfinch	99	0.076	Green-tailed Towhee	4	0.003
Grasshopper Sparrow	96	0.074	Yellow-breasted Chat	3	0.002
Song Sparrow	94	0.072	Western Wood-Pewee	3	0.002
Mourning Dove	67	0.051	Common Nighthawk	3	0.002
Yellow-headed Blackbird	64	0.049	Horned Lark	2	0.002
Rufous-sided Towhee	50	0.038	Eastern Kingbird	2	0.002
Cliff Swallow	50	0.038	Dark-eyed Junco	2	0.002
Northern Oriole	47	0.036	Downy Woodpecker	1	0.001
Common Yellowthroat	47	0.036	Common Grackle	1	0.001
Pine Siskin	43	0.033	Chestnut-sided warbler	1	0.001
American Robin	37	0.028	Black-headed Grosbeak	1	0.001
Blue Grosbeak	36	0.028			
Yellow Warbler	34	0.026			
Western Kingbird	33	0.025			
Brewer's Blackbird	32	0.025			
Black-billed Magpie	27	0.021			
Lark Sparrow	25	0.019			
Chipping Sparrow	20	0.015			
Say's Phoebe	19	0.015			
House Wren	16	0.012			
Lesser Goldfinch	15	0.011			

(1) Relative abundance

Table 3-28. Migratory bird relative abundance by habitat in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Red-winged Blackbird	10	16	49	0.327	422	3.79		
Red-winged Blackbird	20	48	74	0.649	422	11.37		
Red-winged Blackbird	30	213	111	1.919	422	50.47		
Red-winged Blackbird	54	4	131	0.031	422	0.95		
Red-winged Blackbird	93	14	28	0.500	422	3.32		
Red-winged Blackbird	110	51	352	0.145	422	12.09		
Red-winged Blackbird	211	20	50	0.400	422	4.74		
Red-winged Blackbird	212	37	79	0.468	422	8.77		
Red-winged Blackbird	230	14	159	0.088	422	3.32		
Red-winged Blackbird	322	5	67	0.075	422	1.18	422	0.3231
Grasshopper Sparrow	10	7	49	0.143	96	7.29		
Grasshopper Sparrow	20	10	74	0.135	96	10.42		
Grasshopper Sparrow	30	13	111	0.117	96	13.54		
Grasshopper Sparrow	110	8	352	0.023	96	8.33		
Grasshopper Sparrow	211	2	50	0.040	96	2.08		
Grasshopper Sparrow	212	4	79	0.051	96	4.17		
Grasshopper Sparrow	230	8	159	0.050	96	8.33		
Grasshopper Sparrow	322	16	67	0.239	96	16.67		
Grasshopper Sparrow	323	28	170	0.165	96	29.17	96	0.0735
House Finch	10	5	49	0.102	369	1.36		
House Finch	20	2	74	0.027	369	0.54		
House Finch	30	11	111	0.099	369	2.98		
House Finch	93	1	28	0.036	369	0.27		
House Finch	110	209	352	0.594	369	56.64		
House Finch	211	2	50	0.040	369	0.54		
House Finch	212	25	79	0.316	369	6.78		
House Finch	230	56	159	0.352	369	15.18		
House Finch	322	23	67	0.343	369	6.23		
House Finch	323	2	170	0.012	369	0.54		
House Finch	324	28	28	1.000	369	7.59		
House Finch	510	5	1	5.000	369	1.36	369	0.2825
Pine Siskin	10	5	49	0.102	43	11.63		
Pine Siskin	20	5	74	0.068	43	11.63		
Pine Siskin	110	9	352	0.026	43	20.93		
Pine Siskin	230	24	159	0.151	43	55.81	43	0.0329
Lesser Goldfinch	20	1	74	0.014	15	6.67		
Lesser Goldfinch	110	10	352	0.028	15	66.67		
Lesser Goldfinch	230	4	159	0.025	15	26.67	15	0.0115
American Goldfinch	10	2	49	0.041	99	2.02		
American Goldfinch	20	1	74	0.014	99	1.01		
American Goldfinch	110	56	352	0.159	99	56.57		
American Goldfinch	211	5	50	0.100	99	5.05		
American Goldfinch	212	7	79	0.089	99	7.07		
American Goldfinch	230	28	159	0.176	99	28.28	99	0.0758
Lark Sparrow	212	1	79	0.013	25	4.00		
Lark Sparrow	230	4	159	0.025	25	16.00		
Lark Sparrow	323	18	170	0.106	25	72.00		
Lark Sparrow	324	2	28	0.071	25	8.00	25	0.0191
Common Nighthawk	110	1	352	0.003	3	33.33		
Common Nighthawk	323	2	170	0.012	3	66.67	3	0.0023

Table 3-28. Migratory bird relative abundance by habitat in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. In Habitat (t)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Northern Flicker	110	4	352	0.011	5	80.00		
Northern Flicker	230	1	159	0.006	5	20.00	5	0.0038
Western Wood-Pewee	110	2	352	0.006	3	66.67		
Western Wood-Pewee	230	1	159	0.006	3	33.33	3	0.0023
Yellow Warbler	110	33	352	0.094	34	97.06		
Yellow Warbler	322	1	67	0.015	34	2.94	34	0.0260
Chestnut-sided warbler	230	1	159	0.006	1	100.00	1	0.0008
Horned Lark	323	2	170	0.012	2	100.00	2	0.0015
Brewer's Blackbird	93	15	28	0.536	32	46.88		
Brewer's Blackbird	110	15	352	0.043	32	46.88		
Brewer's Blackbird	322	1	67	0.015	32	3.13		
Brewer's Blackbird	323	1	170	0.006	32	3.13	32	0.0245
Common Yellowthroat	10	3	49	0.061	47	6.38		
Common Yellowthroat	20	7	74	0.095	47	14.89		
Common Yellowthroat	30	17	111	0.153	47	36.17		
Common Yellowthroat	110	11	352	0.031	47	23.40		
Common Yellowthroat	211	2	50	0.040	47	4.26		
Common Yellowthroat	212	3	79	0.038	47	6.38		
Common Yellowthroat	230	4	159	0.025	47	8.51	47	0.0360
Blue Grosbeak	10	1	49	0.020	36	2.78		
Blue Grosbeak	20	2	74	0.027	36	5.56		
Blue Grosbeak	110	24	352	0.068	36	66.67		
Blue Grosbeak	211	3	50	0.060	36	8.33		
Blue Grosbeak	212	1	79	0.013	36	2.78		
Blue Grosbeak	230	3	159	0.019	36	8.33		
Blue Grosbeak	322	2	67	0.030	36	5.56	36	0.0276
Cliff Swallow	30	7	111	0.063	50	14.00		
Cliff Swallow	54	9	131	0.069	50	18.00		
Cliff Swallow	93	2	28	0.071	50	4.00		
Cliff Swallow	110	1	352	0.003	50	2.00		
Cliff Swallow	212	24	79	0.304	50	48.00		
Cliff Swallow	323	5	170	0.029	50	10.00		
Cliff Swallow	324	2	28	0.071	50	4.00	50	0.0383
Barn Swallow	10	3	49	0.061	149	2.01		
Barn Swallow	20	11	74	0.149	149	7.38		
Barn Swallow	30	11	111	0.099	149	7.38		
Barn Swallow	54	17	131	0.130	149	11.41		
Barn Swallow	110	48	352	0.136	149	32.21		
Barn Swallow	211	6	50	0.120	149	4.03		
Barn Swallow	212	18	79	0.228	149	12.08		
Barn Swallow	230	7	159	0.044	149	4.70		
Barn Swallow	322	7	67	0.104	149	4.70		
Barn Swallow	323	5	170	0.029	149	3.36		
Barn Swallow	324	9	28	0.321	149	6.04		
Barn Swallow	510	7	1	7.000	149	4.70	149	0.1141
Northern Oriole	10	1	49	0.020	47	2.13		
Northern Oriole	110	36	352	0.102	47	76.60		
Northern Oriole	211	3	50	0.060	47	6.38		
Northern Oriole	212	2	79	0.025	47	4.20		
Northern Oriole	230	5	159	0.031	47	10.64	47	0.0360

Table 3-28. Migratory bird relative abundance by habitat in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Yellow-breasted Chat	230	3	159	0.019	3	100.00	3	0.0023
Dark-eyed Junco	110	2	352	0.006	2	100.00	2	0.0015
Song Sparrow	10	1	49	0.020	94	1.06		
Song Sparrow	20	6	74	0.081	94	6.38		
Song Sparrow	30	20	111	0.180	94	21.28		
Song Sparrow	110	32	352	0.091	94	34.04		
Song Sparrow	211	1	50	0.020	94	1.06		
Song Sparrow	212	9	79	0.114	94	9.57		
Song Sparrow	230	25	159	0.157	94	26.60	94	0.0720
Brown-headed Cowbird	110	6	352	0.017	10	60.00		
Brown-headed Cowbird	230	4	159	0.025	10	40.00	10	0.0077
Sage Thrasher	230	4	159	0.025	7	57.14		
Sage Thrasher	420	3	6	0.500	7	42.86	7	0.0054
Black-capped Chickadee	110	5	352	0.014	14	35.71		
Black-capped Chickadee	212	2	79	0.025	14	14.29		
Black-capped Chickadee	230	7	159	0.044	14	50.00	14	0.0107
Black-headed Grosbeak	110	1	352	0.003	1	100.00	1	0.0008
Green-tailed Towhee	110	1	352	0.003	4	25.00		
Green-tailed Towhee	230	3	159	0.019	4	75.00	4	0.0031
Rufous-sided Towhee	110	1	352	0.003	50	2.00		
Rufous-sided Towhee	230	49	159	0.308	50	98.00	50	0.0383
Black-billed Magpie	10	5	49	0.102	27	18.52		
Black-billed Magpie	20	2	74	0.027	27	7.41		
Black-billed Magpie	110	15	352	0.043	27	55.56		
Black-billed Magpie	230	4	159	0.025	27	14.81		
Black-billed Magpie	323	1	170	0.006	27	3.70	27	0.0207
Downy Woodpecker	110	1	352	0.003	1	100.00	1	0.0008
Vesper Sparrow	10	7	49	0.143	202	3.47		
Vesper Sparrow	20	6	74	0.081	202	2.97		
Vesper Sparrow	30	15	111	0.135	202	7.43		
Vesper Sparrow	110	24	352	0.068	202	11.88		
Vesper Sparrow	211	8	50	0.160	202	3.96		
Vesper Sparrow	212	13	79	0.165	202	6.44		
Vesper Sparrow	230	13	159	0.082	202	6.44		
Vesper Sparrow	322	20	67	0.299	202	9.90		
Vesper Sparrow	323	83	170	0.488	202	41.09		
Vesper Sparrow	324	3	28	0.107	202	1.49		
Vesper Sparrow	420	5	6	0.833	202	2.48		
Vesper Sparrow	530	5	1	5.000	202	2.48	202	0.1547
Common Grackle	93	1	28	0.036	1	100.00	1	0.0008
Eastern Phoebe	110	7	352	0.020	9	77.78		
Eastern Phoebe	230	2	159	0.013	9	22.22	9	0.0069
Say's Phoebe	30	2	111	0.018	19	10.53		
Say's Phoebe	93	1	28	0.036	19	5.26		
Say's Phoebe	110	4	352	0.011	19	21.05		
Say's Phoebe	211	1	50	0.020	19	5.26		
Say's Phoebe	212	3	79	0.038	19	15.79		
Say's Phoebe	230	2	159	0.013	19	10.53		
Say's Phoebe	322	2	67	0.030	19	10.53		
Say's Phoebe	323	2	170	0.012	19	10.53		

Table 3-28. Migratory bird relative abundance by habitat in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Say's Phoebe	324	2	28	0.071	19	10.53	19	0.0145
Broad-tailed Hummingbird	20	1	74	0.014	4	25.00		
Broad-tailed Hummingbird	110	1	352	0.003	4	25.00		
Broad-tailed Hummingbird	230	1	159	0.006	4	25.00		
Broad-tailed Hummingbird	322	1	67	0.015	4	25.00	4	0.0031
Chipping Sparrow	110	9	352	0.026	20	45.00		
Chipping Sparrow	212	1	79	0.013	20	5.00		
Chipping Sparrow	230	10	159	0.063	20	50.00	20	0.0153
Western Meadowlark	10	12	49	0.245	147	8.16		
Western Meadowlark	20	4	74	0.054	147	2.72		
Western Meadowlark	30	14	111	0.126	147	9.52		
Western Meadowlark	54	1	131	0.008	147	0.68		
Western Meadowlark	93	2	28	0.071	147	1.36		
Western Meadowlark	110	38	352	0.108	147	25.85		
Western Meadowlark	211	6	50	0.120	147	4.08		
Western Meadowlark	212	17	79	0.215	147	11.56		
Western Meadowlark	230	7	159	0.044	147	4.76		
Western Meadowlark	322	13	67	0.194	147	8.84		
Western Meadowlark	323	28	170	0.165	147	19.05		
Western Meadowlark	324	4	28	0.143	147	2.72		
Western Meadowlark	510	1	1	1.000	147	0.68	147	0.1126
European Starling	10	1	49	0.020	500	0.20		
European Starling	30	37	111	0.333	500	7.40		
European Starling	110	239	352	0.679	500	47.80		
European Starling	211	2	50	0.040	500	0.40		
European Starling	212	204	79	2.582	500	40.80		
European Starling	322	13	67	0.194	500	2.60		
European Starling	324	4	28	0.143	500	0.80	500	0.3828
House Wren	110	11	352	0.031	16	68.75		
House Wren	230	5	159	0.031	16	31.25	16	0.0123
American Robin	10	1	49	0.020	37	2.70		
American Robin	20	4	74	0.054	37	10.81		
American Robin	30	1	111	0.009	37	2.70		
American Robin	110	17	352	0.048	37	45.95		
American Robin	212	1	79	0.013	37	2.70		
American Robin	230	8	159	0.050	37	21.62		
American Robin	322	4	67	0.060	37	10.81		
American Robin	324	1	28	0.036	37	2.70	37	0.0283
Eastern Kingbird	110	2	352	0.006	2	100.00	2	0.0015
Western Kingbird	93	1	28	0.036	33	3.03		
Western Kingbird	110	24	352	0.068	33	72.73		
Western Kingbird	212	4	79	0.051	33	12.12		
Western Kingbird	322	2	67	0.030	33	6.06		
Western Kingbird	323	1	170	0.006	33	3.03		
Western Kingbird	324	1	28	0.036	33	3.03	33	0.0253
Yellow-headed Blackbird	30	64	111	0.577	64	100.00	64	0.0490
Mourning Dove	20	2	74	0.027	67	2.99		
Mourning Dove	30	6	111	0.054	67	8.96		
Mourning Dove	110	50	352	0.142	67	74.63		
Mourning Dove	212	1	79	0.013	67	1.49		

Table 3-28. Migratory bird relative abundance by habitat in summer 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Mourning Dove	230	2	159	0.013	67	2.99		
Mourning Dove	322	2	67	0.030	67	2.99		
Mourning Dove	323	3	170	0.018	67	4.48		
Mourning Dove	324	1	28	0.036	67	1.49	67	0.0513

(1) Relative abundance

Table 3-29. Migratory bird relative abundance sitewide in fall 1998 based on multi-species census surveys

Common Name	Total Observed	Obs./Min. in Fall (1)	Common Name	Total Observed	Obs./Min. in Fall (1)
House Finch	157	0.134	Common Raven	1	0.001
Vesper Sparrow	147	0.126	Dark-eyed Junco	1	0.001
White-crowned Sparrow	95	0.081	Northern mockingbird	1	0.001
Western Meadowlark	71	0.061	Sage Thrasher	1	0.001
American Robin	56	0.048	Green-tailed Towhee	1	0.001
European Starling	55	0.047	Downy Woodpecker	1	0.001
Pine Siskin	52	0.044	Eastern Kingbird	1	0.001
American Tree Sparrow	52	0.044			
Black-billed Magpie	36	0.031			
American Goldfinch	32	0.027			
Mourning Dove	29	0.025			
Barn Swallow	27	0.023			
Song Sparrow	27	0.023			
Black-capped Chickadee	26	0.022			
Chestnut-collared longspur	24	0.020			
Red-winged Blackbird	23	0.020			
Northern Flicker	21	0.018			
Rufous-sided Towhee	19	0.016			
Grasshopper Sparrow	16	0.014			
Common Yellowthroat	11	0.009			
Blue Grosbeak	10	0.009			
Horned Lark	9	0.008			
Say's Phoebe	7	0.006			
Chipping Sparrow	7	0.006			
Western Kingbird	6	0.005			
Lark Sparrow	5	0.004			
Brewer's Blackbird	5	0.004			
Eastern Phoebe	3	0.003			
House Wren	3	0.003			

(1) Relative abundance

Table 3-30. Migratory bird relative abundance by habitat in fall 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Red-winged Blackbird	30	20	87	0.230	23	86.96		
Red-winged Blackbird	2E-04	2	310	0.006	23	8.70		
Red-winged Blackbird	212	1	79	0.013	23	4.35	23	0.0196
Grasshopper Sparrow	10	1	50	0.020	16	6.25		
Grasshopper Sparrow	110	12	310	0.039	16	75.00		
Grasshopper Sparrow	211	1	35	0.029	16	6.25		
Grasshopper Sparrow	323	2	138	0.014	16	12.50	16	0.0137
House Finch	10	2	50	0.040	157	1.27		
House Finch	20	1	88	0.011	157	0.64		
House Finch	30	3	87	0.034	157	1.91		
House Finch	110	51	310	0.165	157	32.48		
House Finch	211	1	35	0.029	157	0.64		
House Finch	212	19	79	0.241	157	12.10		
House Finch	230	15	164	0.091	157	9.55		
House Finch	322	17	90	0.189	157	10.83		
House Finch	323	6	138	0.043	157	3.82		
House Finch	324	42	29	1.448	157	26.75	157	0.1341
Chestnut-collared longspur	323	24	138	0.174	24	100.00	24	0.0205
Pine Siskin	110	15	310	0.048	52	28.85		
Pine Siskin	230	24	164	0.146	52	46.15		
Pine Siskin	322	13	90	0.144	52	25.00	52	0.0444
American Goldfinch	20	1	88	0.011	32	3.13		
American Goldfinch	30	2	87	0.023	32	6.25		
American Goldfinch	110	13	310	0.042	32	40.63		
American Goldfinch	211	1	35	0.029	32	3.13		
American Goldfinch	230	15	164	0.091	32	46.88	32	0.0273
Lark Sparrow	10	5	50	0.100	5	100.00	5	0.0043
Northern Flicker	10	1	50	0.020	21	4.76		
Northern Flicker	110	18	310	0.058	21	85.71		
Northern Flicker	212	1	79	0.013	21	4.76		
Northern Flicker	230	1	164	0.006	21	4.76	21	0.0179
Common Raven	322	1	90	0.011	1	100.00	1	0.0009
Horned Lark	322	2	90	0.022	9	22.22		
Horned Lark	323	7	138	0.051	9	77.78	9	0.0077
Brewer's Blackbird	212	5	79	0.063	5	100.00	5	0.0043
Common Yellowthroat	10	1	50	0.020	11	9.09		
Common Yellowthroat	20	1	88	0.011	11	9.09		
Common Yellowthroat	30	3	87	0.034	11	27.27		
Common Yellowthroat	110	4	310	0.013	11	36.36		
Common Yellowthroat	211	1	35	0.029	11	9.09		
Common Yellowthroat	212	1	79	0.013	11	9.09	11	0.0094
Blue Grosbeak	20	1	88	0.011	10	10.00		
Blue Grosbeak	110	9	310	0.029	10	90.00	10	0.0085
Barn Swallow	10	1	50	0.020	27	3.70		
Barn Swallow	20	1	88	0.011	27	3.70		
Barn Swallow	30	8	87	0.092	27	29.63		
Barn Swallow	54	3	96	0.031	27	11.11		
Barn Swallow	110	10	310	0.032	27	37.04		
Barn Swallow	230	2	164	0.012	27	7.41		
Barn Swallow	322	2	90	0.022	27	7.41	27	0.0231

Table 3-30. Migratory bird relative abundance by habitat in fall 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Dark-eyed Junco	110	1	310	0.003	1	100.00	1	0.0009
Song Sparrow	10	2	50	0.040	27	7.41		
Song Sparrow	20	2	88	0.023	27	7.41		
Song Sparrow	30	6	87	0.069	27	22.22		
Song Sparrow	110	9	310	0.029	27	33.33		
Song Sparrow	211	1	35	0.029	27	3.70		
Song Sparrow	230	7	164	0.043	27	25.93	27	0.0231
Northern mockingbird	110	1	310	0.003	1	100.00	1	0.0009
Sage Thrasher	230	1	164	0.006	1	100.00	1	0.0009
Black-capped Chickadee	110	12	310	0.039	26	46.15		
Black-capped Chickadee	212	2	79	0.025	26	7.69		
Black-capped Chickadee	230	12	164	0.073	26	46.15	26	0.0222
Green-tailed Towhee	230	1	164	0.006	1	100.00	1	0.0009
Rufous-sided Towhee	110	2	310	0.006	19	10.53		
Rufous-sided Towhee	230	17	164	0.104	19	89.47	19	0.0162
Black-billed Magpie	20	1	88	0.011	36	2.78		
Black-billed Magpie	110	18	310	0.058	36	50.00		
Black-billed Magpie	212	3	79	0.038	36	8.33		
Black-billed Magpie	230	9	164	0.055	36	25.00		
Black-billed Magpie	323	5	138	0.036	36	13.89	36	0.0307
Downy Woodpecker	110	3	310	0.010	3	100.00	1	0.0009
Vesper Sparrow	10	5	50	0.100	147	3.40		
Vesper Sparrow	20	6	88	0.068	147	4.08		
Vesper Sparrow	30	6	87	0.069	147	4.08		
Vesper Sparrow	110	21	310	0.068	147	14.29		
Vesper Sparrow	211	1	35	0.029	147	0.68		
Vesper Sparrow	212	7	79	0.089	147	4.76		
Vesper Sparrow	230	3	164	0.018	147	2.04		
Vesper Sparrow	322	7	90	0.078	147	4.76		
Vesper Sparrow	323	81	138	0.587	147	55.10		
Vesper Sparrow	324	10	29	0.345	147	6.80	147	0.1255
Eastern Phoebe	110	3	310	0.010	3	100.00	3	0.0026
Say's Phoebe	20	1	88	0.011	7	14.29		
Say's Phoebe	110	2	310	0.006	7	28.57		
Say's Phoebe	212	3	79	0.038	7	42.86		
Say's Phoebe	230	1	164	0.006	7	14.29	7	0.0060
American Tree Sparrow	20	4	88	0.045	52	7.69		
American Tree Sparrow	30	7	87	0.080	52	13.46		
American Tree Sparrow	110	20	310	0.065	52	38.46		
American Tree Sparrow	211	3	35	0.086	52	5.77		
American Tree Sparrow	212	3	79	0.038	52	5.77		
American Tree Sparrow	230	14	164	0.085	52	26.92		
American Tree Sparrow	420	1	5	0.200	52	1.92	52	0.0444
Chipping Sparrow	20	1	88	0.011	7	14.29		
Chipping Sparrow	110	2	310	0.006	7	28.57		
Chipping Sparrow	212	4	79	0.051	7	57.14	7	0.0060
Western Meadowlark	10	8	50	0.160	71	11.27		
Western Meadowlark	30	1	87	0.011	71	1.41		
Western Meadowlark	110	11	310	0.035	71	15.49		
Western Meadowlark	212	2	79	0.025	71	2.82		

Table 3-30. Migratory bird relative abundance by habitat in fall 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Western Meadowlark	230	7	164	0.043	71	9.86		
Western Meadowlark	322	19	90	0.211	71	26.76		
Western Meadowlark	323	22	138	0.159	71	30.99		
Western Meadowlark	324	1	29	0.034	71	1.41	71	0.0606
European Starling	110	35	310	0.113	55	63.64		
European Starling	324	20	29	0.690	55	36.36	55	0.0470
House Wren	10	1	50	0.020	3	33.33		
House Wren	230	2	164	0.012	3	66.67	3	0.0026
American Robin	110	24	310	0.077	56	42.86		
American Robin	230	32	164	0.195	56	57.14	56	0.0478
Eastern Kingbird	20	1	88	0.011	1	100.00	1	0.0009
Western Kingbird	110	4	310	0.013	6	66.67		
Western Kingbird	322	2	90	0.022	6	33.33	6	0.0051
Mourning Dove	30	2	87	0.023	29	6.90		
Mourning Dove	110	22	310	0.071	29	75.86		
Mourning Dove	230	2	164	0.012	29	6.90		
Mourning Dove	323	3	138	0.022	29	10.34	29	0.0248
White-crowned Sparrow	30	2	87	0.023	95	2.11		
White-crowned Sparrow	110	28	310	0.090	95	29.47		
White-crowned Sparrow	211	2	35	0.057	95	2.11		
White-crowned Sparrow	212	35	79	0.443	95	36.84		
White-crowned Sparrow	230	26	164	0.159	95	27.37		
White-crowned Sparrow	323	2	138	0.014	95	2.11	95	0.0811

(1) Relative abundance

Table 3-31. Migratory bird relative abundance sitewide in winter 1998 based on multi-species census surveys

Common Name	Total Observed	Obs./Min. in Winter (1)
Black-billed Magpie	69	0.069
American Tree Sparrow	53	0.053
Northern Flicker	24	0.024
Red-winged Blackbird	21	0.021
Black-capped Chickadee	17	0.017
European Starling	17	0.017
Horned Lark	12	0.012
House Finch	8	0.008
Song Sparrow	8	0.008
Common Raven	4	0.004
Western Meadowlark	4	0.004
American Robin	2	0.002
Northern Shrike	1	0.001
Downy Woodpecker	1	0.001

(1) Relative abundance

Table 3-32. Migratory bird relative abundance by habitat in winter 1998 based on multi-species census surveys

Common Name	Hab Type	Total # Observed	Total Time in Habitat	Obs/Min. in Habitat (1)	Total # Obs for Species	Percent of Species/Habtype	Total Observed	Obs./Min. in Spring
Red-winged Blackbird	20	19	126	0.151	21	90.48		
Red-winged Blackbird	30	2	49	0.041	21	9.52	21	0.0209
House Finch	110	6	300	0.020	8	75.00		
House Finch	324	2	59	0.034	8	25.00	8	0.0080
Northern Flicker	20	1	126	0.008	24	4.17		
Northern Flicker	30	1	49	0.020	24	4.17		
Northern Flicker	110	17	300	0.057	24	70.83		
Northern Flicker	212	1	94	0.011	24	4.17		
Northern Flicker	220	2	2	1.000	24	8.33		
Northern Flicker	230	2	137	0.015	24	8.33	24	0.0239
Common Raven	110	2	300	0.007	4	50.00		
Common Raven	322	2	93	0.022	4	50.00	4	0.0040
Horned Lark	30	1	49	0.020	12	8.33		
Horned Lark	230	2	137	0.015	12	16.67		
Horned Lark	323	1	114	0.009	12	8.33		
Horned Lark	324	8	59	0.136	12	66.67	12	0.0120
Northern Shrike	30	1	49	0.020	1	100.00	1	0.0010
Song Sparrow	20	2	126	0.016	8	25.00		
Song Sparrow	30	1	49	0.020	8	12.50		
Song Sparrow	110	1	300	0.003	8	12.50		
Song Sparrow	212	1	94	0.011	8	12.50		
Song Sparrow	230	3	137	0.022	8	37.50	8	0.0080
Black-capped Chickadee	110	5	300	0.017	17	29.41		
Black-capped Chickadee	212	2	94	0.021	17	11.76		
Black-capped Chickadee	230	10	137	0.073	17	58.82	17	0.0169
Black-billed Magpie	110	25	300	0.083	69	36.23		
Black-billed Magpie	212	4	94	0.043	69	5.80		
Black-billed Magpie	230	33	137	0.241	69	47.83		
Black-billed Magpie	322	2	93	0.022	69	2.90		
Black-billed Magpie	324	3	59	0.051	69	4.35		
Black-billed Magpie	540	2	3	0.667	69	2.90	69	0.0688
Downy Woodpecker	110	1	300	0.003	1	100.00	1	0.0010
American Tree Sparrow	20	2	126	0.016	53	3.77		
American Tree Sparrow	30	1	49	0.020	53	1.89		
American Tree Sparrow	110	16	300	0.053	53	30.19		
American Tree Sparrow	211	5	26	0.192	53	9.43		
American Tree Sparrow	212	14	94	0.149	53	26.42		
American Tree Sparrow	230	13	137	0.095	53	24.53		
American Tree Sparrow	324	2	59	0.034	53	3.77	53	0.0528
Western Meadowlark	230	1	137	0.007	4	25.00		
Western Meadowlark	322	3	93	0.032	4	75.00	4	0.0040
European Starling	30	2	49	0.041	17	11.76		
European Starling	110	15	300	0.050	17	88.24	17	0.0169
American Robin	110	1	300	0.003	2	50.00		
American Robin	322	1	93	0.011	2	50.00	2	0.0020

(1) Relative abundance

Table 3-33. Bird diversity (Simpson's Index) for each season by year and habitat

Season	Habitat	Survey Year						
		1991	1993	1994	1995	1996	1997	1998
Spring								
	Riparian Shrubland - *Amorpha*	ND	ND	0.86	0.86	0.89	0.83	0.88
	Mesic Mixed Grasslands	ND	ND	0.90	0.88	0.83	0.86	0.78
	Reclaimed Grasslands	ND	ND	0.76	0.73	0.76	0.70	0.59
	Upland Shrubs	ND	ND	0.92	0.94	0.92	0.91	0.92
	Wetlands	ND	ND	0.73	0.72	0.85	0.85	0.78
	Riparian Woodland Complex	ND	ND	0.90	0.90	0.93	0.94	0.89
	Xeric Mixed Grasslands	ND	ND	0.84	0.76	0.77	0.81	0.80
Breeding (June only)								
	Riparian Shrubland - *Amorpha*	0.92	0.91	0.92	0.90	0.88	0.90	0.86
	Mesic Mixed Grasslands	0.76	0.84	0.91	0.85	0.88	0.86	0.91
	Reclaimed Grasslands	0.83	0.88	0.85	0.88	0.88	0.85	0.87
	Upland Shrubs	0.89	0.86	0.93	0.93	0.92	0.94	0.92
	Wetlands	0.81	0.70	0.74	0.74	0.83	0.77	0.81
	Riparian Woodland Complex	0.84	0.89	0.92	0.91	0.85	0.88	0.89
	Xeric Mixed Grasslands	0.84	0.83	0.87	0.89	0.81	0.85	0.85
Summer								
	Riparian Shrubland - *Amorpha*	ND	ND	0.91	0.90	0.88	0.86	0.92
	Mesic Mixed Grasslands	ND	ND	0.87	0.88	0.91	0.87	0.90
	Reclaimed Grasslands	ND	ND	0.89	0.89	0.87	0.86	0.88
	Upland Shrubs	ND	ND	0.94	0.94	0.93	0.94	0.94
	Wetlands	ND	ND	0.78	0.79	0.82	0.85	0.84
	Riparian Woodland Complex	ND	ND	0.91	0.91	0.88	0.89	0.92
	Xeric Mixed Grasslands	ND	ND	0.88	0.86	0.79	0.84	0.85
Fall								
	Riparian Shrubland - *Amorpha*	ND	ND	0.87	0.82	0.91	0.90	0.90
	Mesic Mixed Grasslands	ND	ND	0.78	0.87	0.75	0.25	0.78
	Reclaimed Grasslands	ND	ND	0.63	0.81	0.75	0.59	0.81
	Upland Shrubs	ND	ND	0.92	0.93	0.89	0.88	0.88
	Wetlands	ND	ND	0.91	0.84	0.91	0.87	0.90
	Riparian Woodland Complex	ND	ND	0.91	0.82	0.93	0.89	0.93
	Xeric Mixed Grasslands	ND	ND	0.85	0.82	0.72	0.77	0.82
Winter								
	Riparian Shrubland - *Amorpha*	0.67	NA	0.82	NA	NA	0.84	0.89
	Mesic Mixed Grasslands	NA	0.53	0.83	0.90	0.90	0.80	0.87
	Reclaimed Grasslands	NA	NA	0.81	NA	NA	0.64	0.87
	Upland Shrubs	0.82	0.79	0.84	0.81	0.71	0.74	0.86
	Wetlands	0.97	0.80	0.57	0.56	0.73	0.67	0.91
	Riparian Woodland Complex	0.70	0.88	0.77	0.81	0.75	0.66	0.83
	Xeric Mixed Grasslands	NA	0.75	0.30	0.34	0.13	0.50	0.35

ND = no data collected
NA = not applicable

Table 3-34. Species richness for each season by year and habitat

Season	Habitat	Survey Year							
		1991	1993	1994	1995	1996	1997	1998	Total # Since '91
Spring									
	Riparian Shrubland - *Amorpha*	ND	ND	13	13	15	10	18	
	Mesic Mixed Grasslands	ND	ND	17	19	11	12	12	
	Reclaimed Grasslands	ND	ND	14	10	10	8	12	
	Upland Shrubs	ND	ND	27	28	24	22	24	
	Wetlands	ND	ND	26	23	21	20	22	
	Riparian Woodland Complex	ND	ND	30	40	43	36	32	
	Xeric Mixed Grasslands	ND	ND	16	9	13	18	15	
	Total # Species			50	55	57	49	49	91
Breeding (June only)									
	Riparian Shrubland - *Amorpha*	15	18	16	18	12	17	18	
	Mesic Mixed Grasslands	9	11	26	20	14	17	19	
	Reclaimed Grasslands	12	18	15	17	16	11	15	
	Upland Shrubs	17	26	31	34	28	32	24	
	Wetlands	22	28	26	22	23	21	27	
	Riparian Woodland Complex	28	28	30	31	33	31	40	
	Xeric Mixed Grasslands	11	14	22	16	14	15	19	
	Total # Species	42	47	50	47	46	48	54	84
Summer									
	Riparian Shrubland - *Amorpha*	ND	ND	21	18	17	17	23	
	Mesic Mixed Grasslands	ND	ND	29	20	20	19	24	
	Reclaimed Grasslands	ND	ND	19	19	19	13	18	
	Upland Shrubs	ND	ND	37	36	30	40	38	
	Wetlands	ND	ND	30	31	27	27	31	
	Riparian Woodland Complex	ND	ND	37	38	40	38	43	
	Xeric Mixed Grasslands	ND	ND	28	18	19	19	23	
	Total # Species			61	54	58	59	64	98
Fall									
	Riparian Shrubland - *Amorpha*	ND	ND	9	9	11	10	9	
	Mesic Mixed Grasslands	ND	ND	10	11	9	5	9	
	Reclaimed Grasslands	ND	ND	5	7	9	7	10	
	Upland Shrubs	ND	ND	25	26	23	16	27	
	Wetlands	ND	ND	16	12	21	12	17	
	Riparian Woodland Complex	ND	ND	27	20	39	21	32	
	Xeric Mixed Grasslands	ND	ND	13	11	9	11	11	
	Total # Species			42	36	47	31	42	70
Winter									
	Riparian Shrubland - *Amorpha*	2	1	4	4	2	6	6	
	Mesic Mixed Grasslands	4	2	7	4	4	3	4	
	Reclaimed Grasslands	1	1	4	2	1	4	6	
	Upland Shrubs	6	6	12	9	6	8	11	
	Wetlands	8	4	6	9	6	3	7	
	Riparian Woodland Complex	6	9	12	14	8	12	10	
	Xeric Mixed Grasslands	1	4	5	6	4	4	4	
	Total # Species	17	16	20	22	21	18	25	35

ND = no data collected

Table 3-35. Seasonal species richness 1991, 1993-1998

YEAR	WINTER	SPRING	SUMMER	FALL	BREEDING SEASON
1991	17	ND	ND	ND	42
1993	16	ND	ND	ND	47
1994	20	50	61	42	50
1995	22	55	54	36	47
1996	21	57	58	47	46
1997	18	49	59	31	48
1998	25	49	64	42	54

ND = no data collected

Table3-36. Jacard's similarity index for breeding season bird species richness

Year	1991	1993	1994	1995	1996	1997	1998
1991	**1.00**	0.68	0.64	0.56	0.63	0.58	0.60
1993		**1.00**	0.67	0.68	0.60	0.58	0.60
1994			**1.00**	0.67	0.66	0.72	0.68
1995				**1.00**	0.66	0.73	0.60
1996					**1.00**	0.71	0.67
1997						**1.00**	0.62
1998							**1.00**

KEY
Jaccard's Coefficient = a/(a+b+c)

a = those species which both years share
b = those species not present in X group, but present in Y group
c = those species present in X group, gut not present in Y group

Table 3-37. Neotropical migratory bird species richness

Habitat	Survey Year 1994	1995	1996	1997	1998
Riparian Shrubland - *Amorpha*	13	13	15	10	18
Mesic Mixed Grasslands	17	19	11	12	12
Reclaimed Grasslands	14	10	10	8	12
Upland Shrubs	27	28	24	22	24
Wetlands	26	23	21	20	22
Riparian Woodland Complex	30	40	43	36	32
Xeric Mixed Grasslands	16	9	13	18	15

*Data from June (breeding season) only.

Table 3-38. Neotropical migratory bird species richness

Common Name	1994	1995	1996	1997	1998
American Crow	0.04	0.00	0.00	0.00	0.00
American Goldfinch	3.79	6.29	4.05	4.28	7.80
American Kestrel	0.57	0.15	0.23	0.45	0.45
American Robin	1.74	2.05	3.33	2.80	6.40
American Tree Sparrow	0.53	4.92	0.80	1.78	1.36
American Widgeon	0.00	0.00	0.00	0.00	0.04
Bald Eagle	0.34	0.08	0.08	0.04	0.00
Barn Swallow	4.81	4.02	5.27	3.79	6.10
Black-billed Cuckoo	0.00	0.00	0.00	0.00	0.08
Black-billed Magpie	3.94	3.86	3.90	4.92	4.05
Black-capped Chickadee	1.14	1.74	2.58	1.67	1.02
Black-crowned Night-heron	0.00	0.00	0.08	0.00	0.00
Black-headed Grosbeak	0.00	0.00	0.11	0.04	0.00
Black-throated Gray Warbler	0.08	0.00	0.00	0.04	0.00
Blue Grosbeak	0.76	0.49	0.30	1.29	1.29
Blue Jay	0.00	0.08	0.04	0.23	0.00
Blue-gray Gnatcatcher	0.15	0.08	0.00	0.11	0.00
Blue-winged Teal	0.00	0.00	0.04	0.00	0.19
Brewer's Blackbird	1.63	3.30	1.14	2.20	1.14
Brewer's Sparrow	0.00	0.00	0.15	0.34	0.00
Broad-tailed Hummingbird	0.11	0.04	0.08	0.27	0.15
Brown Thrasher	0.00	0.00	0.04	0.00	0.00
Brown-headed Cowbird	1.93	1.40	1.10	2.20	2.88
Canada Goose	0.00	0.00	0.00	0.11	0.00
Cassin's Finch	0.23	0.00	0.00	0.00	0.00
Chestnut-collared Longspur	0.00	0.04	0.00	0.00	0.00
Chestnut-sided Warbler	0.00	0.08	0.00	0.00	0.04
Chipping Sparrow	1.67	0.30	1.17	1.74	1.10
Cinnamon Teal	0.08	0.00	0.00	0.00	0.00
Clay-colored Sparrow	0.00	0.00	0.15	0.00	0.00
Cliff Swallow	4.32	2.61	3.14	2.12	2.50
Common Grackle	0.19	0.11	1.33	0.23	0.15
Common Merganser	0.00	0.04	0.04	0.04	0.00
Common Nighthawk	0.45	0.61	0.42	0.27	0.34
Common Poorwill	0.00	0.00	0.00	0.00	0.08
Common Raven	0.00	0.27	0.04	0.00	0.15
Common Snipe	1.29	0.80	0.98	2.73	1.52
Common Yellowthroat	1.70	1.74	2.16	1.06	2.12
Cooper's Hawk	0.00	0.00	0.04	0.00	0.00
Cordilleran Flycatcher	0.00	0.04	0.00	0.00	0.00
Dark-eyed Junco	0.45	0.53	0.04	0.11	0.11
Double-crested Cormorant	0.00	0.00	0.00	0.00	0.04
Downy Woodpecker	0.04	0.15	0.08	0.00	0.04
Eared Grebe	0.00	0.00	0.04	0.00	0.00
Eastern Kingbird	0.38	0.30	0.23	0.11	1.10
Eastern Phoebe	0.04	0.11	0.11	0.04	0.11
European Starling	7.05	15.30	13.18	12.31	15.08
Ferruginous Hawk	0.04	0.04	0.00	0.00	0.04
Fox Sparrow	0.00	0.00	0.08	0.00	0.00

Table 3-38. Neotropical migratory bird species richness

Common Name	1994	1995	1996	1997	1998
Golden Eagle	0.19	0.11	0.08	0.08	0.08
Golden-crowned Kinglet	0.00	0.00	0.00	0.04	0.11
Grasshopper Sparrow	2.73	2.54	4.51	3.37	4.55
Gray Catbird	0.00	0.04	0.00	0.00	0.04
Great Blue Heron	0.08	0.04	0.04	0.04	0.15
Great Horned Owl	0.98	0.95	0.83	0.61	0.68
Greater Scaup	0.08	0.00	0.00	0.00	0.00
Greater Yellowlegs	0.00	0.00	0.00	0.00	0.08
Green-tailed Towhee	0.42	0.30	1.02	0.64	0.34
Green-winged Teal	0.00	0.00	0.19	0.08	0.19
Hairy Woodpecker	0.00	0.00	0.04	0.00	0.08
Horned Lark	3.14	3.33	2.54	4.24	3.48
House Finch	16.14	12.12	12.23	16.40	14.13
House Sparrow	0.04	0.00	0.00	0.00	0.04
House Wren	0.15	0.45	0.45	0.38	0.57
Killdeer	0.64	0.11	0.19	0.15	0.15
Lapland Longspur	0.00	0.00	0.00	0.00	0.04
Lark Bunting	0.11	0.00	0.30	0.08	0.00
Lark Sparrow	0.00	0.04	0.04	0.23	0.23
Lazuli Bunting	0.00	0.00	0.00	0.00	0.00
Lesser Goldfinch	0.45	0.23	0.45	0.30	0.42
Lincoln's Sparrow	0.00	0.00	0.04	0.04	0.00
Loggerhead Shrike	0.04	0.11	0.08	0.00	0.23
Long-eared Owl	0.00	0.00	0.04	0.04	0.00
MacGillivray's Warbler	0.00	0.08	0.04	0.00	0.00
Mallard	0.98	1.33	1.17	2.05	1.36
Marsh Wren	0.00	0.00	0.04	0.00	0.11
Mountain Bluebird	0.15	0.00	0.57	2.08	0.45
Mountain Chickadee	0.00	0.00	0.04	0.00	0.00
Mourning Dove	5.34	4.36	4.28	3.14	4.51
Northern Flicker	1.10	1.02	0.57	0.87	1.17
Northern Goshawk	0.00	0.00	0.00	0.00	0.00
Northern Harrier	0.45	0.61	0.15	0.34	0.45
Northern Mockingbird	0.00	0.00	0.19	0.00	0.04
Northern Oriole	1.97	1.82	1.86	2.20	2.12
Northern Shrike	0.00	0.00	0.04	0.00	0.04
Pectoral Sandpiper	0.00	0.00	0.00	0.00	0.04
Peregrine Falcon	0.00	0.00	0.00	0.04	0.04
Pied-billed Grebe	0.00	0.00	0.34	0.00	0.00
Pine Siskin	0.11	0.19	0.23	0.19	1.36
Prairie Falcon	0.00	0.04	0.00	0.04	0.04
Purple Finch	0.00	0.00	0.04	0.00	0.00
Red-tailed Hawk	0.95	0.61	0.98	0.68	0.68
Red-winged Blackbird	15.83	15.30	13.14	12.84	14.66
Ring-necked Duck	0.11	0.00	0.57	0.08	0.00
Ring-necked Pheasant	0.04	0.08	0.00	0.00	0.00
Rock Dove	0.00	0.04	0.00	0.00	0.11
Rock Wren	0.23	0.00	0.11	0.08	0.04
Rough-legged Hawk	0.27	0.11	0.04	0.11	0.11

Table 3-38. Neotropical migratory bird species richness

Common Name	1994	1995	1996	1997	1998
Ruby-crowned Kinglet	0.08	0.15	0.00	0.00	0.00
Rufous Hummingbird	0.00	0.00	0.00	0.08	0.00
Rufous Hummingbird	0.00	0.00	0.00	0.08	0.00
Rufous-sided Towhee	3.14	2.84	3.52	3.03	2.92
Sage Thrasher	1.06	0.23	0.68	0.45	0.57
Savannah Sparrow	0.00	0.00	0.00	0.00	0.04
Say's Phoebe	0.87	0.76	1.17	0.91	0.83
Short-eared Owl	0.15	0.00	0.04	0.00	0.08
Solitary Vireo	0.04	0.08	0.00	0.00	0.00
Song Sparrow	7.16	8.07	6.67	7.01	6.55
Sora	0.11	0.04	0.00	0.11	0.00
Swainson's Hawk	0.11	0.00	0.04	0.00	0.04
Swainson's Thrush	0.00	0.11	0.00	0.00	0.00
Townsend's Solitaire	0.00	0.04	0.00	0.04	0.00
Tree Swallow	0.04	0.15	0.00	0.11	0.00
Turkey Vulture	0.27	0.00	0.00	0.08	0.04
Vesper Sparrow	12.42	11.25	12.92	12.69	12.16
Violet-green Swallow	0.15	0.00	0.08	0.08	0.19
Virginia Rail	0.00	0.00	0.04	0.04	0.00
Virginia's Warbler	0.00	0.08	0.00	0.00	0.00
Warbling Vireo	0.04	0.00	0.04	0.00	0.00
Western Kingbird	1.44	1.10	0.95	0.98	0.80
Western Meadowlark	15.30	14.89	18.64	20.80	15.61
Western Wood-Pewee	0.00	0.04	0.08	0.00	0.04
White-breasted Nuthatch	0.00	0.04	0.00	0.00	0.00
White-crowned Sparrow	0.19	1.55	1.29	2.05	0.83
Willow Flycatcher	0.00	0.00	0.00	0.00	0.08
Wilson's Warbler	0.38	0.57	0.49	0.15	0.15
Yellow Warbler	0.61	0.95	0.68	0.53	0.83
Yellow-breasted Chat	0.11	0.19	0.38	0.23	0.27
Yellow-headed Blackbird	0.00	0.00	1.67	0.00	0.00
Yellow-rumped Warbler	0.30	0.27	0.11	0.49	0.08

Note: Density calculations used birds observed at less than 50m from the transect line and flyover observations for selected species.

Table 3-39. Densities[a] of all breeding birds by habitat (1991, 1993-1998)

Habitat	Survey Year						
	1991	1993	1994	1995	1996	1997	1998
Wetlands	208	357	193	155	161	178	188
Riparian Woodland Complex	419	267	293	237	338	338	314
Riparian Shrublands - *Amorpha*	197	193	185	205	85	178	185
Upland Shrublands	137	313	263	248	286	279	273
Mesic Mixed Grasslands	92	102	234	290	113	154	140
Xeric Mixed Grasslands	61	89	78	73	80	79	91
Reclaimed Grasslands	131	101	94	93	86	84	90

[a] Densities are individuals per square kilometer during the month of June.

Table 3-40. Selected bird densities during June

COMMON NAME	1991	1993	1994	1995	1996	1997	1998
European Starling	9.85	3.03	8.24	15.77	23.30	13.21	23.58
Brown-headed Cowbird	1.33	1.33	5.97	2.56	2.70	6.11	6.68
Grasshopper Sparrow	3.60	10.61	6.53	5.82	7.81	7.24	8.38
Black-billed Magpie	2.27	2.08	3.84	2.41	1.85	3.41	4.83
Rufous-sided Towhee	2.27	3.03	3.41	3.41	3.13	3.69	4.55
American Goldfinch	5.30	8.90	8.52	8.66	6.96	9.52	6.25
Black-capped Chickadee	0.00	0.00	0.43	1.28	0.28	0.43	0.85
Yellow Warbler	0.95	1.52	0.43	0.99	1.70	1.56	1.56
Common Snipe	1.14	1.89	1.70	0.99	1.42	1.99	1.99
Blue Grosbeak	1.33	1.89	1.85	0.99	0.85	2.70	1.42
Common Yellowthroat	1.89	3.98	2.84	3.27	2.98	2.56	2.56
Yellow-breasted Chat	0.95	0.19	0.14	0.43	0.85	0.71	0.43
Western Kingbird	2.27	0.38	3.13	2.13	1.56	1.42	1.85
Mourning Dove	8.14	6.25	7.53	8.52	7.24	4.83	7.67
Northern Oriole	4.92	4.17	4.40	3.13	2.41	5.11	3.27
Vesper Sparrow	14.96	14.96	15.20	13.07	14.06	13.92	13.64
Brewer's Blackbird	2.84	8.14	5.54	9.66	3.69	2.13	2.41
Song Sparrow	7.39	6.63	9.52	6.82	5.54	4.97	5.54
Western Meadowlark	18.75	28.60	19.18	15.63	17.05	21.02	15.20
Red-winged Blackbird	24.43	48.48	26.28	23.01	18.75	20.74	20.88
House Finch	38.07	17.80	17.47	17.90	11.36	25.99	16.19
All species combined	**152.65**	**173.86**	**152.13**	**146.45**	**135.51**	**153.27**	**149.72**

Table 3-41. Densities[a] of selected bird species by habitat (1991, 1993-1998)

	SURVEY YEAR						
SUMMARY	1991	1993	1994	1995	1996	1997	1998
Wetlands							
Red-winged Blackbird	83.3	191.1	95.8	75.8	61.7	79.2	78.3
Common Snipe	6.7	10.0	7.5	4.2	5.8	6.7	10.8
Song Sparrow	8.9	10.0	6.7	10.0	6.7	8.3	10.8
Common Yellowthroat	7.8	16.7	9.2	10.8	10.8	8.3	6.7
Riparian Woodland Complex							
House Finch	151.1	66.7	48.3	15.8	50.0	82.5	69.2
European Starling	47.8	16.7	35.0	55.0	114.2	67.5	65.0
Northern Oriole	14.4	13.3	9.2	9.2	9.2	18.3	10.8
American Goldfinch	17.8	27.8	13.3	15.0	15.8	29.2	13.3
Yellow Warbler	4.4	5.6	2.5	4.2	7.5	4.2	4.2
Brown-headed Cowbird	2.2	2.2	16.7	3.3	10.0	9.2	10.8
Blue Grosbeak	4.4	5.6	4.2	2.5	3.3	10.8	2.5
Riparian Shrubland - *Amorpha*							
Vesper Sparrow	26.7	36.7	32.5	17.5	22.5	17.5	10.0
Mourning Dove	20.0	10.0	22.5	22.5	10.0	7.5	7.5
European Starling	26.7	0.0	17.5	17.5	10.0	10.0	62.5
Northern Oriole	13.3	10.0	12.5	15.0	2.5	17.5	10.0
Brewer's Blackbird	6.7	23.3	5.0	50.0	0.0	0.0	7.5
Upland Shrublands							
Song Sparrow	20.0	13.3	37.5	28.8	23.8	18.8	13.8
Rufous-sided Towhee	16.7	18.3	25.0	26.3	26.3	26.3	35.0
Brown-headed Cowbird	6.7	3.3	18.8	16.3	8.8	31.3	27.5
Black-billed Magpie	11.7	13.3	28.8	20.0	10.0	23.8	30.0
Yellow-breasted Chat	8.3	1.7	1.3	3.8	7.5	5.0	3.8
Black-capped Chickadee	0.0	0.0	3.8	10.0	2.5	3.8	3.8
Mesic Mixed Grasslands							
Vesper Sparrow	25.0	16.7	20.0	27.5	12.5	16.3	12.5
House Finch	33.3	21.7	48.8	87.5	8.8	43.8	18.8
Western Meadowlark	20.0	28.3	33.8	31.3	17.5	28.8	20.0
Western Kingbird	3.3	0.0	5.0	3.8	2.5	3.8	3.8
Grasshopper Sparrow	0.0	8.3	8.8	13.8	7.5	7.5	8.8
Xeric Mixed Grasslands							
Vesper Sparrow	17.1	22.0	19.5	17.1	26.8	17.7	19.5
Western Meadowlark	13.0	23.6	16.5	12.2	17.7	17.7	17.1
Grasshopper Sparrow	8.1	15.4	9.1	6.7	13.4	12.2	14.6
Reclaimed Grasslands							
Vesper Sparrow	29.3	14.7	17.0	17.0	14.0	18.0	13.0
Western Meadowlark	25.3	25.3	27.0	20.0	19.0	20.0	24.0
Grasshopper Sparrow	10.7	18.7	12.0	9.0	15.0	14.0	12.0

[a] Densities are individuals per square kilometer during the month of June.

Section 4

Conclusion

4. Conclusions

The Site provides a unique refuge along the central Front Range for a large number of bird and mammal species. The presence of this refuge results in large part from most of the Site having been protected for more than two decades from grazing, development, and other disturbances. The area enclosed by the 1950s BZ has experienced this singular habitat protection for more than 40 years. The exclusion of grazing and development has allowed the native prairie/montane ecotonal area in the BZ to rebound from its previously overgrazed state. The Site does, however, suffer from the influences of nearby development, adjacent industrial activities, and regional weed infestations. While wildlife movement corridors continue to remain open, providing more mobile species with the opportunity to enter and leave the Site at will, the Site is becoming more isolated from adjacent ecological communities each year. Continued careful management is necessary to prevent outside and onsite influences from degrading the current high quality of the Site's natural resources.

Large-scale real estate development, mining, and water diversions on other large tracts of land along the Front Range have already destroyed or degraded much of the native habitat that was once available. It is due to the protection and isolation of the BZ that rare or imperiled species, and the present species diversity, are found at the Site. A number of the species at the Site are sensitive species or indicator organisms that by their presence—or more significantly, by their absence—indicate the ecological health of an area.

At the end of the 1998 field season, 251 terrestrial vertebrate species had been verified as using the Site's ecosystems. This is an impressive diversity when compared to the 322 terrestrial vertebrate species found at Rocky Mountain National Park, an area 98 percent larger than the Site. The Site's diversity includes 191 species of birds (19 are raptors), 3 big game species, 11 species of carnivores, 3 lagomorphs, 6 large rodents, 22 small mammal species, 9 reptiles, and 7 amphibians recorded since 1991. No definitive inventory of arthropods and other invertebrates has been made, but baseline sampling produced a large array of arthropod taxa. This high species diversity and continued use of the Site by numerous special-concern species verifies that habitat quality for these species has remained acceptable and that ecosystem functions are being maintained.

One of the goals of the *Integrated Monitoring Plan – Ecology* (K-H 1997e) is to make annual assessments of endpoints for wildlife populations at the Site. Monitoring performed under the NRCPP tracks the populations of wildlife species and indicates the ecological health of the Site, as well as effects from nearby activities.

A healthy natural environment provides a wide variety of ecological niches. This ecological health is reflected in species richness and population dynamics. All wildlife species in an ecosystem require healthy, well-balanced habitats in which to live and

reproduce. Degraded habitat is reflected by lower numbers and reduced diversity of wildlife. The data collected during the 1998 field effort indicate that wildlife populations are stable and species richness remains high. Therefore, current Site activities are not having an adverse effect on BZ ecosystems.

The mule deer population has fluctuated, and is currently estimated at about 120 animals. Male-to-female and young-to-adult ratios are well within the constraints of what wildlife experts consider a healthy deer herd. Songbird density and diversity numbers indicate stability or slight increases in songbird use of all habitats at the Site. Completing an accurate census of migratory waterfowl, carnivores, and herptiles is more difficult, but these species continued to be observed in numbers similar to past years. The coyote population maintained several packs across the Site, and several natal dens were discovered. It is of interest that mountain lions continue to visit the Site sporadically. This normally shy, secretive species is unusual in predominantly prairie habitat, but the mountain lion may range onto the Site because of the large mule deer herd. Its appearance also illustrates the connectivity of the Site to the montane habitats to the west. The four raptor species that most commonly nest at the Site successfully reared young in 1998. The normal migratory assemblage of waterfowl visited the Site in the spring and fall of 1998, and the species that commonly breed at the Site were recorded with broods of young.

Although the Preble's mouse monitoring effort did not capture a sufficient number of Preble's mice to allow calculation of a population estimate in Rock Creek, the data collected in 1998 indicated that viable populations continue to exist in the Rock Creek drainage and the Dam B-4 population unit. Radio telemetry monitoring results provided valuable new insights into how the Preble's mouse travels and how it uses its habitat. This information has added greatly to the Site's ability to predict Preble's mouse presence, and has given new hints to its behavior.

With the addition of amphibian and fish monitoring, the ecology program has improved its ability to monitor and evaluate the limited aquatic community at the Site. Fish species found in the streams were consistent with those expected in the headwaters. The several amphibians recorded during vocalization surveys confirmed that the species diversity has been maintained over the past several years, and that Site surface waters remain of sufficiently good quality to support such sensitive indicator species.

The long-term, year-round ecological monitoring program conducted under the NRCPP continues to be an essential tool for identifying, describing, and quantifying fluctuations in wildlife populations, wildlife habitat use, and changes in the species that use the Site as year-round or seasonal habitat. Wildlife population densities vary constantly with natural pressures, and only well-integrated, long-term monitoring such as this can identify consequences of natural influences versus consequences of human activities. The data produced are an invaluable tool in predicting and avoiding ecological impacts resulting from projected human activities. If sensitive species dwindle in numbers or disappear, a serious environmental health problem is indicated. Monitoring and surveys such as those carried out by the NRCPP detect trends of this sort, and act as an "early warning system"

for impending ecological problems. This function will become increasingly important as remediation activities at the Site increase, and will play an essential role in assessing natural resource damages.

Section 5

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5. References

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Appendix A

Code Entry Explanations and Instructions for Data Entry of Sitewide and Multi-Species Surveys, and Fortuitous Observations of Significant Species, into Ecological Database

CODE ENTRY EXPLANATIONS AND INSTRUCTIONS FOR DATA ENTRY OF SITEWIDE AND MULTI-SPECIES SURVEYS, AND FORTUITOUS OBSERVATIONS OF SIGNIFICANT SPECIES, INTO ECOLOGICAL DATABASE

Data for Multi-species Census Surveys shall be entered into the Multi-species Database (MSD), and data from Sitewide Significant Species Surveys shall be n=entered into the Sitewide Survey Database (SSD) using the codes listed below.

Observer
Enter initials of the primary observer (up to 3 letters).

Date of Observation
Input observation date as mm/dd/yy (e.g., 02/04/98)

Time of Observation
Enter observation time using 24-hour military time clock (e.g., 1310 for 1:10 PM)

Type of Observation (Obs. type)

Observation Codes:

1	=	Visual (includes dead individuals)
2	=	Trap/Net Capture
3	=	Hand Capture
4	=	Radio Fix
5	=	Tracks
6	=	Scat/Pellets
7	=	Hair/Feathers/Other Remains
8	=	Sound/Vocalization
9	=	Photographic Evidence
10	=	Nest/Eggs

Taxonomic Group Code (Taxn Grup)
Groups to be recorded include big game mammals; furbearers; small game mammals; upland game birds; waterfowl, shorebirds and wading birds; raptors; reptiles and amphibians; and threatened, endangered, and candidate species.

Taxonomic Group Codes:

B	=	Big Game	L	=	Lepidoptera
C	=	Carnivores	P	=	Soil Protozoa
Y	=	Lagomorphs (Rabbits and Hares), Large Rodents (Muskrats, Prairie Dogs), Bats	N	=	Soil Nematodes
H	=	Herptiles (Reptiles/Amphibians)	A	=	Soil Arthropods
F	=	Fish	1	=	Surface/Terrestrial Invertebrates
R	=	Raptors	Q	=	Aquatic Invertebrates

U	=	Upland Game Birds	O	=	Zooplankton
W	=	Waterbirds (Waterfowl, Shorebirds, Wading Birds)	V	=	Vegetation
S	=	Songbirds	G	=	Algae

Species Code
Enter species code from Current Approved Species Code (see Attachment A).

Observation Area (Admin Area)
Enter code for observation area relative to Rocky Flats:

Administrative Area Codes:

PA	=	Protected Area
IA	=	Industrial Area
BZ	=	Buffer Zone
EA	=	Extended Observation Area*

*Within 10 km of Rocky Flats boundary.

Name of Observation Location (Site Name)
Enter name of transect.

Name of Operable Unit (OU)
Enter Operable Unit name of observation area, if applicable.

North-South Rocky Flats Grid Code (RF Grid N)
Enter alphanumeric code number (1-17) for location of observation according to Rocky Flats Grid (see Attachment B for map).

East-West Rocky Flats Grid Code (RF Grid E)
Enter alphanumeric code letter (A-U) for location of observation according to Rocky Flats Grid.

Activity Codes (Activity & Activity 2)
Enter primary activity code in Activity column and secondary activity code in Activity 2 column.

Activity Codes:

Fauna:					
0	=	Inactive/Immobile	13	=	Socialization/Playing
1	=	In Transit	14	=	Being Prey
2	=	Walking/Leisurely Flight	15	=	Drinking
3	=	Running/Rapid Flight	16	=	Swimming
4	=	Fleeing	17	=	Territorial Behavior
5	=	Feeding/Hunting	18	=	Dead
6	=	Courtship	19	=	Defense of Young
7	=	Nursing/Feeding Young	20	=	Giving Birth
8	=	Nesting/Incubating	21	=	Sick/Injured

9	=	Nesting/Brooding	22	=	Asleep
10	=	Nest Building	23	=	In Trap
11	=	Fighting/Aggression	24-49	=	(Open)
12	=	Grooming/Preening			
Flora:					
50	=	Died Back/Standing Dead			
51	=	Vegetative			
52	=	In Bud			
53	=	In Flower			
54	=	In Fruit/Seed			

Description of Habitat at Observation Location (Hab Type, Hab Type 2)
Enter habitat code for Hab Type. Enter secondary habitat code for Hab Type 2. See list below for wildlife habitat codes.

Wildlife Habitat Codes:

Code	Habitat Description	Code	Habitat Description
000	Aquatic and Wetlands Habitats Group	093	Impoundment Edge
	Terrestrial Subgroup	094	Dugout Edge
010	Wet Meadow/Marsh Ecotone	095	Ditch Edge
020	Short Marsh (Carex/Juncus)	100	Woodlands Habitats Group
030	Tall Marsh (Typha/Scirpus)	110	Riparian Woodland (Populus, Salix and Associated)
	Open Water Subgroup	120	Ponderosa Woodland (Pinus ponderosa and Associated)
040	Streams and Rivers	125	Douglas-fir Woodland (Pseudotsuga menziesii and Associated)*
041	Intermittent Stream - Riffle	130	Tree Plantings (Ornamentals and Shelterbelts)
042	Intermittent Stream - Run	200	Shrublands Habitats Group
043	Intermittent Stream - Pool	210	Riparian Shrubland (Salix, Amorpha, and Associated)
044	Persistent Stream -Riffle	211	Riparian Shrubland - Amorpha
045	Persistent Stream - Run	212	Riparian Shrubland - Salix
046	Persistent Stream - Pool	220	Short Upland Shrubland (Symphoricarpos and Associated)
047	Ditch (Drainage/Irrigation) - Riffle	230	Tall Upland Shrubland (Crataegus, Prunus, and Associated)
048	Ditch (Drainage/Irrigation) - Run	240	Rabbitbrush Shrubland (Chrysothamnus and Associated)
049	Ditch (Drainage/Irrigation) - Pool	250	Mountain Mahogany/Bitterbrush Shrubland (Cercocarpus, Purshia, and Associated)
050	Ponds and Impoundments	260	Savannah Shrubland (Rhus, Ribes, Physocarpus, and Associated)
051	Natural Pond - Littoral Zone*	300	Grasslands Habitats Group
052	Natural Pond - Limnitic Zone*	310	Short Grassland (Buchloe, Bouteloua, and Associated)
053	Natural Pond - Profundal Zone*	320	Mixed Grassland (General)
054	Impoundment - Littoral Zone	322	Mesic Mixed Grassland (Agropyron, Bouteloua, Poa, and Associated)
055	Impoundment - Limnitic Zone	323	Xeric Mixed Grassland (Andropogon, Stipa, Muhlenbergia, and Associated)
056	Impoundment - Profundal Zone	324	Reclaimed Mixed Grassland (Planted grass mixtures)
057	Dugout/Excavated Pond - Littoral Zone	325	Overgrazed Pasture
058	Dugout/Excavated Pond - Limnitic Zone	400	Disturbance Habitat Group
059	Dugout/Excavated Pond - Profundal Zone	410	Annual Grass/Forb (Bromus japonicus, Bromus tectorium, Centaurea, Helianthus)
060	Lakes and Reservoirs*	420	Disturbed/Barren Lands (Roads, dirt lots)
061	Littoral Zone	430	Cultivated Lands*
062	Limnitic Zone	500	Structures and Structure Associations Habitats Group
063	Profundal Zone	510	Transmission Lines

070	Springs and Seeps	520	Buildings/Structures
071	Persistent	530	Rock and Gravel Piles
072	Intermittent	540	Roadside/Fencerow Complex
080	Groundwater	550	Debris Piles
Emergent Subgroup		560	Fence
090	Mudflats	600	Special Features Group*
091	Stream Edge	610	Cliffs
092	Natural Pond Edge*	620	Caves

Temperature During Observation (Temp)
Enter temperature in degrees Celsius, enter temperatures below zero with a minus (e.g., -4°C).

Wind Speed (Wind Speed)
Enter approximate wind speed in miles per hour. If a range is entered on the datasheet, use the rounded average of values (e.g., if 5-10 mph was recorded, the entry would be entered as 8 mph)

Wind Direction (Wind Direct)
Enter wind direct using directional code up to 2 letters.

Wind Direction Codes:

N	=	North
NE	=	Northeast
E	=	East
SE	=	Southeast
S	=	South
SW	=	Southwest
W	=	West
NW	=	Northwest

Significant Weather Conditions Present (Weather)

Weather Condition Codes:

0	=	No significant weather conditions
1	=	Fog/smog, visibility less than 1 km
2	=	Drizzle or mist
3	=	Rain
4	=	Hail
5	=	Snow or sleet
6	=	Thunderstorm
7	=	Blowing sand or dust

Group Size
This will be calculated automatically after following fields are entered.

Number of Males (Male)
Enter number of males.

Number of Females (Female)
Enter number of females.

Number of Young (Young)
Enter number of young.

Number of Unclassified Individuals (Un-Classd)
Enter number of unclassified individuals.

SPECIES CODES FOR DATA ENTRY

AMPHIBIANS		
AMBYSTOMATIDAE		
Ambystoma tigrinum	Tiger Salamander	AMTI1
PELOBATIDAE		
Scaphiophus bombifrons	Plains Spadefoot	SCBO1
BUFONIDAE		
Bufo cognatus	Great Plains Toad	BUCO1
Bufo woodhousei	Woodhouse's Toad	BUWO1
HYLIDAE		
Pseudacris triseriatus maculata	Boreal Chorus Frog	PSTR1
RANIDAE		
Rana catesbeiana	Bullfrog	RACA1
Rana pipiens	Northern Leopard Frog	RAPI1
REPTILES		
CHELYDRIDAE		
Chrysemys picta	Western Painted Turtle	CHPI1
IGUANIDAE		
Phynosoma douglassi	Short-horned Lizard	PHDO1
Sceloporus undulatus	Eastern Fence Lizard	SCUN1
COLUBRIDAE		
Coluber constrictor	Eastern Yellowbelly Racer	COCO1
Pituophis melanoleucus	Bullsnake	PIME1
Thamnophis radix	Western Plains Garter Snake	THRA1
Thamnophis sirtalis	Red-sided Garter Snake	THSI1
VIPERIDAE		
Crotalus viridis	Prairie Rattlesnake	CRVI1

BIRDS

PODICIPEDIDAE

Aechmophorus occidentalis	Western Grebe	AEOC1
Podiceps nigricollis	Eared Grebe	PONI1
Podilymbus podiceps	Pied-billed Grebe	POPO1

PELECANIDAE

Pelecanus erythrorhynchos	American White Pelican	PEER1

PHALACROCORACIDAE

Phalacrocorax auritus	Double-crested Cormorant	PHAU1

ARDEIDAE

Ardea herodias	Great Blue Heron	ARHE1
Butorides striatus	Green-backed Heron	BUST1
Nycticorax nycticorax	Black-crowned Night-Heron	NYNY1

ANATIDAE

Aix sponsa	Wood Duck	AISP1
Anas acuta	Northern Pintail	ANAC1
Anas americana	American Wigeon	ANAM1
Anas clypeata	Northern Shoveler	ANCL1
Anas crecca	Green-winged Teal	ANCR1
Anas cyanoptera	Cinnamon Teal	ANCY1
Anas discors	Blue-winged Teal	ANDI1
Anas platyrhynchos	Mallard	ANPL1
Anas strepera	Gadwall	ANST1
Aythya affinis	Lesser Scaup	AYAF1
Aythya americana	Redhead	AYAM1
Aythya collaris	Ring-necked Duck	AYCO1
Aythya marila	Greater Scaup	AYMA1
Aythya valisineria	Canvasback	AYVA1
Branta canadensis	Canada Goose	BRCA1
Bucephala albeola	Bufflehead	BUAL1
Bucephala clangula	Common Goldeneye	BUCL1
Chen caerulescens	Snow Goose	CHCA1
Lophodytes cucullatus	Hooded Merganser	LOCU1
Mergus merganser	Common Merganser	MEME1

CATHARTIDAE

Cathartes aura	Turkey Vulture	CAAU1

ACCIPITRIDAE

Accipiter cooperii	Cooper's Hawk	ACCO1
Accipiter gentili	Northern Goshawk	ACGE1
Accipiter striatus	Sharp-shinned Hawk	ACST1
Aquila chrysaetos	Golden Eagle	AQCH1
Buteo jamaicensis	Red-tailed Hawk	BUJA1
Buteo lagopus	Rough-legged Hawk	BULA1
Buteo regalis	Ferruginous Hawk	BURE1
Buteo swainsoni	Swainson's Hawk	BUSW1
Circus cyaneus	Northern Harrier	CICY1
Haliaeetus leucocephalus	Bald Eagle	HALE1
Pandion haliaetus	Osprey	PAHA1
FALCONIDAE		
Falco columbarius	Merlin	FACO1
Falco mexicanus	Prairie Falcon	FAME1
Falco peregrinus	American Peregrine Falcon	FAPE1
Falco sparverius	American Kestrel	FASP1
PHASIANIDAE		
Meleagris gallopavo	Wild Turkey	MEGA1
Phasianus colchicus	Ring-necked Pheasant	PHCO1
RALLIDAE		
Fulica americana	American Coot	FUAM1
GRUIDAE		
Grus canadensis	Sandhill Crane	GRCA1
SCOLOPACIDAE		
Limnodromus scolopaceus	Long-billed Dowitcher	LISC1
STRIGIDAE		
Asio flammeus	Short-eared Owl	ASFL1
Asio otus	Long-eared Owl	ASOT1
Athene cunicularia	Burrowing Owl	ATCU1
Bubo virginianus	Great Horned Owl	BUVI1

APODIDAE			
Cypseloides niger	Black Swift		CYNI1
TYRANNIDAE			
Empidonax occidentalis	Cordilleran Flycatcher		EMDI1
Empidonax traillii	Willow Flycatcher		EMTR1
LANIIDAE			
Lanius ludovicianus	Loggerhead Shrike		LALU1
Emberizinae			
Ammodramus bairdii	Baird's Sparrow		AMBA1
MAMMALS			
ORDER CHIROPTERA			
VESPERTILIONIDAE			
Myotis subulatus (=M. ciliolabrum)	Small-footed Myotis		MYSU1
ORDER LAGOMORPHA			
LEPORIDAE			
Lepus californicus	Black-tailed Jackrabbit		LECA1
Lepus townsendii	White-tailed Jackrabbit	LETO1	
Sylvilagus audubonii	Desert Cottontail		SYAU1
ORDER RODENTIA			
SCIURIDAE			
Cynomys ludovicianus	Black-tailed Prairie Dog		CYLU1
Sciurus niger	Eastern Fox Squirrel		SCNI1
CASTORIDAE			
Castor canadensis	Beaver		CACA1

MURIDAE

Ondatra zibethicus	Muskrat	ONZI1

ZAPODIDAE

Zapus hudsonius preblei	Preble's Meadow Jumping Mouse	ZAHU1

ERETHIZONTIDAE

Erethizon dorsatum	Common Porcupine	ERDO1

ORDER CARNIVORA

URSIDAE

Ursus americanus	American Black Bear	URAM1

PROCYONIDAE

Procyon lotor	Raccoon	PRLO1

MUSTELIDAE

Mephitis mephitis	Striped Skunk	MEME1
Mustela frenata	Long-tailed Weasel	MUFR1
Mustela vison	Mink	MUVI1
Taxidea taxus	American Badger	TATA1

CANIDAE

Canis latrans	Coyote	CALA1
Urocyon cinereoargenteus	Common Gray Fox	URCI1
Vulpes vulpes	Red Fox	VUVU1

FELIDAE

Felis concolor	Mountain Lion	FECO1
Lynx rufus	Bobcat	LYRU1

ORDER ARTIODACTYLA

CERVIDAE

Cervus elaphus	Elk (Wapiti)	CEEL1
Odocoileus hemionus	Mule Deer	ODHE1
Odocoileus virginianus	White-tailed Deer	ODVI1
Odocoileus hemionus x virginianus	Mule X White-tailed Deer	HEXV1

SPECIES CODES FOR DATA ENTRY

AMPHIBIANS		
AMBYSTOMATIDAE		
Ambystoma tigrinum	Tiger Salamander	AMTI1
PELOBATIDAE		
Scaphiophus bombifrons	Plains Spadefoot	SCBO1
BUFONIDAE		
Bufo cognatus	Great Plains Toad	BUCO1
Bufo woodhousei	Woodhouse's Toad	BUWO1
HYLIDAE		
Pseudacris triseriatus maculata	Boreal Chorus Frog	PSTR1
RANIDAE		
Rana catesbeiana	Bullfrog	RACA1
Rana pipiens	Northern Leopard Frog	RAPI1
REPTILES		
CHELYDRIDAE		
Chrysemys picta	Western Painted Turtle	CHPI1
IGUANIDAE		
Phynosoma douglassi	Short-horned Lizard	PHDO1
Sceloporus undulatus	Eastern Fence Lizard	SCUN1
COLUBRIDAE		
Coluber constrictor	Eastern Yellowbelly Racer	COCO1
Pituophis melanoleucus	Bullsnake	PIME1
Thamnophis radix	Western Plains Garter Snake	THRA1
Thamnophis sirtalis	Red-sided Garter Snake	THSI1
VIPERIDAE		
Crotalus viridis	Prairie Rattlesnake	CRVI1

BIRDS

PODICIPEDIDAE

Aechmophorus occidentalis	Western Grebe	AEOC1
Podiceps nigricollis	Eared Grebe	PONI1
Podilymbus podiceps	Pied-billed Grebe	POPO1

PELECANIDAE

Pelecanus erythrorhynchos	American White Pelican	PEER1

PHALACROCORACIDAE

Phalacrocorax auritus	Double-crested Cormorant	PHAU1

ARDEIDAE

Ardea herodias	Great Blue Heron	ARHE1
Butorides striatus	Green-backed Heron	BUST1
Nycticorax nycticorax	Black-crowned Night-Heron	NYNY1

ANATIDAE

Aix sponsa	Wood Duck	AISP1
Anas acuta	Northern Pintail	ANAC1
Anas americana	American Wigeon	ANAM1
Anas clypeata	Northern Shoveler	ANCL1
Anas crecca	Green-winged Teal	ANCR1
Anas cyanoptera	Cinnamon Teal	ANCY1
Anas discors	Blue-winged Teal	ANDI1
Anas platyrhynchos	Mallard	ANPL1
Anas strepera	Gadwall	ANST1
Aythya affinis	Lesser Scaup	AYAF1
Aythya americana	Redhead	AYAM1
Aythya collaris	Ring-necked Duck	AYCO1
Aythya marila	Greater Scaup	AYMA1
Aythya valisineria	Canvasback	AYVA1
Branta canadensis	Canada Goose	BRCA1
Bucephala albeola	Bufflehead	BUAL1
Bucephala clangula	Common Goldeneye	BUCL1
Chen caerulescens	Snow Goose	CHCA1
Lophodytes cucullatus	Hooded Merganser	LOCU1
Mergus merganser	Common Merganser	MEME1

CATHARTIDAE

Cathartes aura	Turkey Vulture	CAAU1

ACCIPITRIDAE		
Accipiter cooperii	Cooper's Hawk	ACCO1
Accipiter gentili	Northern Goshawk	ACGE1
Accipiter striatus	Sharp-shinned Hawk	ACST1
Aquila chrysaetos	Golden Eagle	AQCH1
Buteo jamaicensis	Red-tailed Hawk	BUJA1
Buteo lagopus	Rough-legged Hawk	BULA1
Buteo regalis	Ferruginous Hawk	BURE1
Buteo swainsoni	Swainson's Hawk	BUSW1
Circus cyaneus	Northern Harrier	CICY1
Haliaeetus leucocephalus	Bald Eagle	HALE1
Pandion haliaetus	Osprey	PAHA1
FALCONIDAE		
Falco columbarius	Merlin	FACO1
Falco mexicanus	Prairie Falcon	FAME1
Falco peregrinus	American Peregrine Falcon	FAPE1
Falco sparverius	American Kestrel	FASP1
PHASIANIDAE		
Meleagris gallopavo	Wild Turkey	MEGA1
Phasianus colchicus	Ring-necked Pheasant	PHCO1
RALLIDAE		
Fulica americana	American Coot	FUAM1
GRUIDAE		
Grus canadensis	Sandhill Crane	GRCA1
SCOLOPACIDAE		
Limnodromus scolopaceus	Long-billed Dowitcher	LISC1
STRIGIDAE		
Asio flammeus	Short-eared Owl	ASFL1
Asio otus	Long-eared Owl	ASOT1
Athene cunicularia	Burrowing Owl	ATCU1
Bubo virginianus	Great Horned Owl	BUVI1

APODIDAE		
Cypseloides niger	Black Swift	CYNI1
TYRANNIDAE		
Empidonax occidentalis	Cordilleran Flycatcher	EMDI1
Empidonax traillii	Willow Flycatcher	EMTR1
LANIIDAE		
Lanius ludovicianus	Loggerhead Shrike	LALU1
Emberizinae		
Ammodramus bairdii	Baird's Sparrow	AMBA1
MAMMALS		
ORDER CHIROPTERA		
VESPERTILIONIDAE		
Myotis subulatus (=M. ciliolabrum)	Small-footed Myotis	MYSU1
ORDER LAGOMORPHA		
LEPORIDAE		
Lepus californicus	Black-tailed Jackrabbit	LECA1
Lepus townsendii	White-tailed Jackrabbit	LETO1
Sylvilagus audubonii	Desert Cottontail	SYAU1
ORDER RODENTIA		
SCIURIDAE		
Cynomys ludovicianus	Black-tailed Prairie Dog	CYLU1
Sciurus niger	Eastern Fox Squirrel	SCNI1
CASTORIDAE		
Castor canadensis	Beaver	CACA1

MURIDAE		
Ondatra zibethicus	Muskrat	ONZI1
ZAPODIDAE		
Zapus hudsonius preblei	Preble's Meadow Jumping Mouse	ZAHU1
ERETHIZONTIDAE		
Erethizon dorsatum	Common Porcupine	ERDO1
ORDER CARNIVORA		
URSIDAE		
Ursus americanus	American Black Bear	
URAM1		
PROCYONIDAE		
Procyon lotor	Raccoon	PRLO1
MUSTELIDAE		
Mephitis mephitis	Striped Skunk	MEME1
Mustela frenata	Long-tailed Weasel	MUFR1
Mustela vison	Mink	MUVI1
Taxidea taxus	American Badger	TATA1
CANIDAE		
Canis latrans	Coyote	CALA1
Urocyon cinereoargenteus	Common Gray Fox	URCI1
Vulpes vulpes	Red Fox	VUVU1
FELIDAE		
Felis concolor	Mountain Lion	FECO1
Lynx rufus	Bobcat	LYRU1
ORDER ARTIODACTYLA		
CERVIDAE		
Cervus elaphus	Elk (Wapiti)	CEEL1
Odocoileus hemionus	Mule Deer	ODHE1
Odocoileus virginianus	White-tailed Deer	ODVI1
Odocoileus virginianus	Mule X White-tailed Deer	HEXVI

Appendix B

1998 Preble's Meadow Jumping Mouse Study

1998 Study of the Preble's Meadow Jumping Mouse at the Rocky Flats Environmental Technology Site

Introduction

Small mammal field efforts in 1998 at the Rocky Flats Environmental Technology Site (Site) concentrated on studying Preble's meadow jumping mouse (*Zapus hudsonius preblei*) populations in Walnut Creek and Rock Creek. The efforts in each drainage addressed different goals. In Walnut Creek, the effort concentrated on confirming the presence of the Pond B-4 population.

The 1998 Rock Creek trapping was performed both in known occurrence areas and in new locations within the drainage. The effort consisted of two major components: 1) a mark-and-recapture study to estimate the population, and 2) a radio telemetry tracking effort to monitor movements of individual mice within the drainage. These information needs were identified by Site ecologists, and confirmed by the statewide scientific team that is evaluating the Preble's mouse. Rock Creek was selected for the 1998 effort in keeping with the staggered schedule called for by the Site's Integrated Monitoring Plan (IMP; K-H 1997a). An additional radio telemetry session was conducted in conjunction with late-season trapping in Rock and Walnut Creeks.

During 1996 and 1997 monitoring (K-H 1997c), individuals were captured in new segments of Woman Creek, and both a male and a female were observed traveling moderate distances (0.75 to 1 mile) within the creek drainage. These observations suggested a continuous distribution of Preble's mice along the middle third of Woman Creek, with at least some individuals dispersing to breed, forage, or find hibernation sites. This 1998 study was designed to provide more information on movement of Preble's mice within a contiguous natural drainage, to further understand the role that movement plays in a population's survival.

The main objectives of the 1998 field effort were to determine nightly and monthly movement patterns of Preble's mice within Rock Creek, monitor selected known population centers in Rock Creek, as well as one in Walnut Creek, and study the demographics of the Rock Creek population. These objectives were addressed by trapping in areas of known Preble's mouse occurrence and in areas in the Rock Creek drainage where they have not been documented, and by monitoring individual mice via radio tracking. Population estimates were attempted using mark-and-recapture methodology; however, the assumptions of this methodology were not met. An alternative upper-bound estimate is presented.

During the 1998 monitoring effort, each Preble's mouse captured was marked using a passive integrated transponder (PIT) tag, which will serve as permanent identification for that individual. The mark-and-recapture technique relied on a "closed" (White et al.

1982) four-trap-night period, which can be compared from season to season or year to year. Population estimates were calculated based on the Lincoln-Peterson Index (Golley et al. 1975).

Study Questions

The 1998 field effort was designed to address the questions listed below.

Movement and Dispersal

General question: *What distances do Preble's mice move during midsummer within the Rock Creek drainage (based on radio telemetry)?*

Specific questions:

- How far does an individual mouse move during one night (average and maximum distances)?
- How far does an individual mouse move during one month (average and maximum distances)?
- What is the maximum distance perpendicular to the stream at which mice are detected?
- What is the apparent travel route (e.g., through the riparian corridor or otherwise)?
- What areas that would currently not be classified as Preble's mouse habitat can be identified as "habitat gaps crossed" or "barriers to movement"?

Trapping and Population Estimates

General question: *How many Preble's mice are in the Rock Creek drainage?*

Specific questions:

- What are the population estimates for each transect trapped, assuming that a four-trap-night session approximates a "closed" population?
- What are the age and sex ratios at each transect?

Vegetation Type/Habitat Characteristics

General question: *If Preble's mice are found in new locations of Rock Creek, are they found in the same type of habitat as they occupy elsewhere on the Site?*

Specific questions:

- When Preble's mice are captured in new areas, are the habitat characteristics the same as in known capture locations?
- In the event that breeding or nesting areas are located, what is the general habitat description of these areas?
- Are habitat characteristics of breeding or nesting areas different from the current known habitat?

Supplemental Radio Telemetry Work

The supplemental late-season radio telemetry work addressed two general questions:

- Where are Preble's mouse hibernacula found in Rock Creek and the B-4 dam area of Walnut Creek?
- Do Preble's mice tend to congregate in common areas during the late season?

Methods

Trapping

Trapping for Preble's meadow jumping mice and other small mammals followed the procedures for small mammals outlined in the *EMD Operating Procedures Manual Volume V* (DOE 1994) and conformed to the U.S. Fish and Wildlife Service *Interim Survey Guidelines for Preble's Meadow Jumping Mouse* (USFWS 1997). Animals were trapped in Longworth and Sherman small-mammal live traps using Purina® Sweet Feed as bait.

Walnut Creek Trapping — Trapping in Walnut Creek was restricted to the previously established sample site below the B-4 Dam. One hundred traps were established as four parallel transects of 25 traps each, all placed on the south side of the stream. Traps within each transect were placed 5 m apart, and transects were separated by 10 m. Starting with the first transect running parallel to the stream bank, each successive transect was placed upgradient. The trapping effort was divided into early- and late-season sessions, with trapping performed for a minimum of seven days over the course of

each two-week session. Trapping was conducted from 2 June to 11 June (first session) and from 9 September to 17 September (second session).

Rock Creek Trapping — To facilitate estimation of the Preble's mouse population in Rock Creek, the sampling frame encompassed all known and suitable habitat within the drainage. This sampling frame consisted of 25 1-hectare sampling sites, from which 10 sites (Figure 1) were selected at random for trapping. The ten sites were trapped over two sessions (17 June to 2 July and 24 August to 11 September). During each session, five sites were trapped the first week, and the other five were trapped during the second week.

At each selected site, a transect of 50 traps was established as two rows of 25 traps each, running parallel to the stream on either side. The traps were spaced 5 meters (m) apart, with the two parallel rows about 10 m apart. A transect is considered a representative sample of a trapping area.

Each transect was run for seven days or until 350 trap nights per site was achieved. The seven-day trapping period ensured that each site could be considered "closed" (i.e., no migration or deaths), yet still allowed for multiple mark-recapture estimates. A closed site is a basic assumption for employing mark-recapture estimates (White et al. 1982).

Each small mammal captured was identified to species, age, and sex. Any evidence of breeding activity, such as lactating or pregnant females and scrotal males, was noted. Each Preble's mouse captured was measured for key identifying characteristics, including head and body length, ear length, tail length, hind-foot length, and body weight.

Weather conditions were recorded at the time the traps were checked. All data were recorded on approved field data sheets, entered into the Ecology database, verified, and validated.

Marking

Population estimates relied on mark-and-recapture methodology. All Preble's mice captured in Rock and Walnut Creeks were marked with Passive Integrated Transponder (PIT) tags. Protocols were followed for inserting the PIT tags as developed by the Preble's Mouse Science Team in the spring of 1998. Every individual Preble's mouse captured was marked, whether they were collared or not. During subsequent recapture efforts, all Preble's mice will be "read" with the PIT tag reader.

Radio Telemetry

The field work for radio telemetry included conducting field trials of equipment, establishing telemetry monitoring stations, trapping mice and affixing collars, and finally, radio tracking individuals in the field. The telemetry procedures were developed at the

U.S. Air Force Academy by the Colorado Natural Heritage Program and adopted by the Preble's Mouse Science Team. These steps are described in detail below.

Two Telonics, Inc., Model TR-2 receivers were used to monitor the collared mice, with a TR-1 receiver available to serve as back up. The transmitters operated at a frequency of 172–174 MHz.

Equipment Field Testing

The receivers were tested for performance and maximum detectable range prior to trapping. Each transmitter was tested for performance just prior to collaring. Specific information on performing these trials was provided by Telonics, Inc.

Establishment of Telemetry Stations

Ten preliminary "monitoring stations" were established at locations on each side of the creek that offered a clear line of sight to a large area. New stations were established when mice moved into new areas or when a new station was more efficient for taking readings. Coordinates for all stations were obtained using a global positioning system (GPS) unit, recorded in UTMs, then converted to State Plane coordinates. The stations were located within an accuracy of 0.5 m to provide the most accurate data for estimating locations and traveling distances.

Radio Telemetry Readings

Telemetry work began as soon as the first mouse was collared. Only adults were collared, and an attempt was made to collar the same number of males and females. The first-session collaring effort in Rock Creek began June 19 and continued until July 1, during which time, eight individuals were collared. The second-session collaring effort began September 1 and continued until September 10; one individual in Walnut Creek and three in Rock Creek were collared. Telemetry tracking performed concurrent with trapping efforts was distinguished in field notebooks from tracking that was done after the trapping was finished.

First-session telemetry was conducted mainly at night. Animals were located as often as possible, with a preliminary minimum of twice per night. If once or twice a night was all that could be achieved, then field personnel searched for individuals during various time frames on different nights of the week, in order to observe their movements during most nighttime hours. Field personnel avoided approaching too closely or pursuing the collared animal, because observation of normal movements was essential. Each person taking readings recorded all locations in a field notebook by noting the date, time, station number, collar frequency, whether trapping was being conducted at the time, and the compass direction from which the signal was emanating.

Compass bearings to each transmitter were collected from at least three monitoring stations to ensure a minimum of two valid bearings. Every effort was made to ensure that bearings were more than 60° and less than 120° from one another. In this manner, the most accurate location data were gathered. Bearings from the established monitoring stations were recreated in ArcView® using a program developed by Ternary Spatial Research of Denver. The intersection of valid bearing lines approximated the transmitter's location. The UTM coordinates of the estimated points were created in ArcView® and transferred into a telemetry database.

When telemetry tracking was finished, all locations were quality checked and analyzed. Then maximum and average distances traveled for each individual were calculated.

Habitat Characterization

Habitat was characterized at the trap station (microsite) level. Within Rock Creek sites, microsite habitat was characterized only where Preble's mice had not been captured previously or where breeding or nesting has been documented. No habitat characterization was conducted in conjunction with Walnut Creek trapping. The objective of the 1998 effort in Walnut Creek was simply to conduct a Preble's mouse presence/absence survey.

Beginning on July 20, individual Rock Creek trap stations from each successful transect were characterized, and these ten stations were used to characterize the entire transect. The 10 stations were predetermined as stations 2, 7, 12, 17, 21, 28, 32, 36, 42, and 46. The actual trap stations where Preble's mice were captured were substituted for predetermined stations, as long as the entire length of the trapping transect could be characterized.

Microsite Habitat Parameters

Three different types of habitat information were gathered within a 3-m radius (28.3 m^2) of the selected trap stations: plant species composition, physical habitat, and vegetation structure. Physical habitat measurements are non-vegetative, abiotic features of the habitat.

Nine physical measurements were taken: 1) the trap position in relation to the canopy, 2) slope aspect, 3) slope angle, 4) slope position, 5) moisture gradient, 6) soil texture at the trap station, 7) distance to the stream, 8) whether the trap station was inside or outside the canopy, and 8) distance to the nearest continuous woody riparian canopy. Table 1 lists the habitat endpoints and the methods used to measure them.

Characterizing plant species composition entailed identifying the generalized habitat types, determining the plant species richness within the 3-m radius (center located at the trap station), and noting all woody species that make up the canopy (if any) at the trap station.

The following three vegetation structural measurements were made at each trap station: 1) tree/shrub canopy cover; 2) vertical vegetation density; and 3) a visual estimate of foliar cover for trees, shrubs, subshrubs, grasses, and forbs.

Tree/shrub canopy cover was measured using a spherical crown densiometer placed 1 m above the ground at the center of the 3-m radius. A vegetation profile board (1-m^2 graduated by decimeters; after Nudds 1977), read at a distance of 10 m, was used to measure vertical vegetation density. Foliar cover estimates were determined using cover classes (see Attachments A and B).

A woody index and an herbaceous index were devised using the cover class estimates of trees, shrubs, subshrubs, grass, and forbs. The woody index summed the values for trees, shrubs, and subshrubs, with a possible cover value of 300 percent in some cases. The herbaceous index summed the values for grass and forbs. This measure provided an additional means of examining vegetation structure.

In previous years, woody vegetation height, the number of woody stems per plot, and the woody vegetation density distribution were recorded, and a visual estimate of foliar cover was made for each woody plant species in the plot. However, these measures partially duplicate the more precise measures of canopy cover and vertical vegetation density, and so were discontinued.

Data Analysis

The Rock Creek Preble's mouse 1998 trapping data were not used to calculate population estimates by mark-recapture methods, because not enough recaptures were made and the assumption of a closed population was not met. Instead, density estimates from past years' trapping (1994–1996) were used, along with habitat area information, to calculate population estimates.

Radio telemetry data were used to calculate the daily (i.e., over 24-hour observation period) and monthly minimum, maximum, and average movements of individuals, as well as maximum distance from the stream that each collared individual was observed. Because data were in the form of triangulated points, and not real-time tracked movement, dispersal routes were estimated.

Using the telemetry data, a data screening process was conducted in which error polygons were created based on points originating from three or more bearings. Any error polygons larger than 0.6 hectares (1.5 acres) were flagged and revisited. Where possible, bearings that appeared to be "bounce-back" signals were removed from a bearing set, creating a new point with only two to three bearings. This usually reduced the error polygon to below 0.5 hectares. If a bounce-back bearing was not apparent, the bearing set was thrown out.

The telemetry data were subjected to an uncertainty analysis. A sampling of 11 groups of bearings that were taken prior to visual observations was used to conduct the analysis. Visual observations had been located with a global positioning system. All bearing groups and visual points were re-created in ArcView®, and the distances of the polygon were measured in relation to the point. The distance across the longest side of each polygon is reported as the uncertainty for point estimation, in an effort to be conservative.

Telemetry data were also used to calculate home ranges for each collared mouse. The Jennrich-Turner home range estimation (Jennrich and Turner 1969) was used to calculate the ellipses. This estimation method likely overestimates home range area for Preble's mice, because an ellipse may be too inflexible to represent the linear habitat that Preble's mice utilize. However, the method does provide a means to compare areas used among individuals, and to illustrate overlap among the ranges. Additionally, this method is particularly applicable to estimates based on small sample sizes.

The habitat endpoints for Preble's mouse habitat characterization (Attachment A) were used to describe new areas where captures were made. New sites were compared to the current Site habitat model parameters. Additionally, comparisons of the habitat endpoints were made between years, where appropriate.

Results

Small Mammal Trapping Results

This section presents general results for all small mammal species, and results specific to the Preble's mouse population in both Rock and Walnut Creeks. Ten transects were run in Rock Creek and one in Walnut Creek for two sessions, early and late summer.

All Small-Mammal Species

During 8,198 trap nights (Table 1) in Rock and Walnut Creeks, 3,972 small mammals were captured. In Rock Creek, meadow voles represented the largest percentage (>51 percent) of the eight small mammal species captured. In Walnut Creek, where far less trapping effort was expended, deer mice represented the largest percentage (>49 percent) of the seven small mammal species captured (Table 1).

Comparing the first and second trapping sessions in Rock Creek (Table 2), deer mice were more prevalent than meadow voles during the first session, and seven small mammal species were observed. In contrast, during the second trapping session, meadow voles were dominant, and with the addition of hispid pocket mice, eight small mammal species were observed. The typical rise in the number of deer mice and harvest mice with the addition of young of the year was not observed this year (Table 2). The number of deer mice observed during the second session was actually lower than during the first.

Preble's Mice

Preble's Mice in Walnut Creek

In Walnut Creek, trapping began on 2 June, and three males and one female Preble's mice were captured (Table 3). This effort documented the continued presence of the population below the B-4 Dam. All three of the males were observed in breeding condition. The female was not.

A second trapping session below the B-4 Dam began 9 September. Only one adult male Preble's mouse was captured. This individual was collared with a radio transmitter. None of the Walnut Creek individuals captured in 1998 were marked from previous years.

This male was tracked for 15 days until its radio transmitter was found under a tree in a pile of Great horned owl pellets. The likely predation event took place approximately three days prior to when the transmitter was found. Therefore, only the first eight days of telemetry data were used to estimate distances for this individual.

Preble's Mice in Rock Creek

Captures of Preble's mice were relatively low compared to previous efforts in Rock Creek (K-H 1996a, b), but were comparable to those in 1994 (DOE 1995). Eight individuals (6 adult males and 2 adult females; Table 3) were captured during the first session, with only two recaptures. Four individuals (one adult male, one juvenile male, and two adult females) were captured during the second session, with only one male being captured a second time. None of the individuals captured during the first session was recaptured during the second session.

A total of 15 captures (including recaptures) were made over both trapping sessions (Table 2). The relative abundance of Preble's mice was 0.21 per 100 trap nights. None of the 12 individuals captured in Rock Creek was marked from previous years. All but the juvenile were fitted with radio transmitters. One collared female from the first session was found dead close to the point of capture (see mortality report submitted 16 July, 1998 [Exponent 1998]). Preble's mice were captured more frequently in the first session than in the second (10 captures versus 5 captures; Table 3).

Population Estimates

In order to calculate a population estimate for each transect in Rock Creek using the mark-recapture methodology, recaptures needed to be in sufficient numbers and the estimate had to be applied to a closed population. As mentioned in the Methods Section, neither of these assumptions was met for either trapping session in Rock Creek. For this reason, mark-recapture estimates are not provided in this report.

Populations can be estimated by employing other means, however, and the Kaiser-Hill Ecology Group has an appropriate amount of detailed information to determine an upper bound on the population for Rock Creek (and for the entire Site) based on habitat and a sampling of Preble's mice densities within appropriate habitat.

Estimates based on available habitat and Preble's mouse densities in Rock Creek, and for all creek drainages at Site, provide an upper bound for the maximum number of individuals that might inhabit the area. These estimates assume that the limiting conditions of disease, predation, and availability of water and food are ignored. Table 4 presents the acreage of available habitat in Rock Creek and in all three creeks at the Site. These vegetation types are combined into two main types, primary and secondary habitat, with regard to apparent Preble's mouse utilization. Primary habitat is wetland and woodland vegetation found adjacent to streams. Secondary habitat is wetland vegetation that is found mainly in the hillside seeps in Rock Creek and other drainages at the Site. Available habitat has been segregated into primary and secondary components, because research at the Site has demonstrated that individuals use areas away from stream-side vegetation (K-H 1996b), and current-year telemetry data indicate that seep wetlands are used. To what extent these secondary components are used is unclear. Therefore, primary and secondary components are provided here to help estimate what population numbers could be if streamside vegetation is used exclusively (i.e., primary only) or if all wetland and woodland vegetation types are used equally (i.e., primary and secondary types combined).

Table 5 provides densities from grid trapping in Rock Creek and other creeks during prior years (1994–1996). These implied densities represent a sampling of suitable habitat using a 1-ha grid trapping area. Traps were placed 10 m apart and run for 10 to 25 days. All Preble's mice captured in 1994 through 1996 were marked and released using toe clipping or ear punches (DOE 1995; K-H 1996a,b,c).

Combining these two sources of information yields Preble's mouse numbers that represent the upper bounds of what the habitat might support given ideal conditions. These estimates are useful because they give an order-of-magnitude confidence as to what the real population numbers could be, given the highest quality habitat over a large stream reach. For example, Rock Creek, including all its tributaries, contains about 4.5 miles of linear stream channel. Table 6 presents the primary and secondary habitat types, the average estimated densities of mice in Rock Creek and all three creeks on the Site, and the upper-bound population estimates. Estimates in both primary habitat and all available habitat (i.e., including secondary habitat) provide a range of values. Rock Creek estimates were between 200 and 862 Preble's mice in the entire drainage. Upper-bound estimates based on habitat in all three drainages on the Site (i.e., all available habitat on Site) were between 792 and 1,946.

Telemetry

Twelve adult Preble's mice captured during 1998 trapping were fitted with radio collars. Collared animals included eight males and four females. Problems occurred with

collared females, in that two of the four females shed their collars after a short period of time (i.e., 1 to 2 days), and a third female was found dead after having had the collar affixed for 12 days (Exponent 1998). All other individuals fared well and were radio tracked for the duration of the battery life of the transmitter, usually 30 to 35 days. Of the individuals tracked for the duration of each session, six male Preble's mice were radio tracked during the first telemetry session (19 June to 6 August), and three (2 males and 1 female) were tracked during the second session (1 September to 5 October).

Data Screening — A total of 56 single bearings were discarded as "bounce-back" signals, four bearing sets were eliminated entirely, and 10 other bearings were removed for various other reasons in the data screening process. This reduced all remaining error polygons to below 0.6 ha. Therefore, the telemetry data set contained 591 bearings, creating 195 points. Also included were GPS locations of 15 captures and 20 visual observations of collared mice. These 230 points were used to calculate all the movement information presented here.

Uncertainty Analysis — Based on a sample comparison of nine points, derived from nine bearing groups and companion observation points (i.e., visuals), uncertainty analysis yielded a worst-case uncertainty of 46 m (151 ft). This was the worst-case scenario for the uncertainty associated with the nine polygons created from the nine bearing groups. The average uncertainty of the sample of bearing groups was 29 m. However, using 46 m to be conservative, we report the accuracy of telemetry points to be known within approximately 46 m (151 ft). Each point is therefore known to the nearest 23 m (worst case) in any direction.

Distribution — The six males tracked during the first session were all in Rock Creek. These six males had different ranges in terms of spatial and temporal distribution. Two of the six males traveled widely during the telemetry session, using a long reach of stream or multiple tributaries. Other males had a distinct area were they could be regularly found, and compared to the wide-ranging males, they used much less of a stream reach. Wide-ranging males tended to travel greater distances (248 m or 813 ft, n = 28) on average, based on daily observation periods (i.e., once every 24 hours). The other males traveled less (95 m or 313 ft, n = 23) on average and stayed within a more well-defined area.

The male mice that were collared during the second session (one in Rock Creek, one in Walnut Creek) traveled much less than any of the first-session males. Daily observations revealed that males approaching hibernation traveled an average of 31 m (103 ft, n = 9). The only female collared during the second session did not follow this trend. She traveled an average of 184 m (604 ft, n = 8) based on daily observations. Observations of this female also documented the use of the mesic grassland as a travel corridor under certain situations. How often this occurs remains unknown, but the subject warrants further investigation because this information could have considerable impact when further defining Preble's mouse habitat with regard to movement corridors.

One of the wider ranging males was tracked on 23 July traveling overland (i.e., away from the stream corridor through uplands) from the main branch of Rock Creek to a

tributary of Rock Creek. This male traveled through 115 m (377 ft) of mesic mixed grassland,[1] then an additional 20 m (66 ft) to the edge of the pediment in tall upland shrub at the high point of this traverse.[2] This high point of the traverse was about 26 m (85 ft) elevation above Rock Creek. He then descended a distance of 80 m (262 ft), about a 12-m (40-ft) drop in elevation. He traveled through Canada thistle (*Cirsium arvense*) and skunk bush sumac (*Rhus aromatica*) on the descent. This overland traverse is important, because prior to this study, all information from the Site indicated that Preble's mice used streamside vegetation as travel corridors and did not travel overland.

During the second session, mice in Rock Creek were tracked to daytime nest sites. Both nests were composed of grass formed in a round ball, with an opening at ground level. The nests were both adjacent to shrubs, but not under the shrub canopy. The male's nest, located in the same general area as a suspected hibernation site, was only 1 m from the stream on a south-facing slope vegetated with grasses and wild plum (*Prunus americana*). The female's nest was found in tall upland shrub adjacent to skunk bush sumac. This second nest was on a steep north-facing slope about 180 m (590 ft) from the stream channel at an elevation of 55 m (180 ft) above the channel.

Both mice monitored during the second session in Rock Creek were also tracked to apparent hibernation sites. The two sites varied greatly in terms of vegetation and proximity to the stream. The site for the male mouse was found only 1 m from the stream on a south-facing slope vegetated with grasses and wild plum. The female's hibernation site was found in tall upland shrub about 155 m (580 ft) from the main channel of Rock Creek at an elevation about 24 m (80 ft) above the channel.

Travel Distances— Using telemetry data points, distances traveled were computed for average and maximum movement over a 24-hour observation period, and average and maximum length of stream reach used over the telemetry session (about 30 days). Additionally, the maximum perpendicular distance from the stream that a mouse was observed is reported. These reported average distances combine data points from all individuals over both sessions.

The average distance a mouse traveled between 24-hour observation periods was 142 m (464 ft). The maximum distance traveled between 24-hour observation periods was 1,025 m (3,363 ft or 0.64 miles).

The linear stream reach used over the telemetry session (about 30 days) is intended to provide the length of stream used by individual mice. The average distance used was 715

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[1] The grassland consists of western wheat grass (*Agropyron smithii*), Canada bluegrass (*Poa compressa*), Kentucky bluegrass (*Poa pratensis*), blue gramma (*Bouteloua gracilis*), and some weedy forbs including knapweed (*Centaurea diffusa*). Grassland vegetation was about 1 to 1.5 feet high.

[2] The tall upland shrub community consists of chokecherry (*Prunus virginiana*) and hawthorn (*Crataegus erythropoda*)

m (2,346 ft or 0.44 miles). The maximum distance used was 1,610 m (5,282 ft or 1.0 mile).

The maximum perpendicular distance away from the Rock Creek stream channel at which an individual was observed was 245 m (804 ft or 0.15 mi). This, as well as all other mouse locations that were a relatively large distance from the steam, was all within the Rock Creek basin and within the context of Rocky Flats seep wetlands. There were no mice observed in xeric areas such as those on top of the pediment in the xeric tallgrass prairie.

Home ranges were calculated for each collared mouse, with a sample size of 20 point estimations. These five home ranges are the result of movements of five adult males in summer. The resulting home ranges are presented in Figure 2 and range from 4 to 31 ha (9.9 to 76.6 acres). These values for Preble's mice are much greater than that of a typical deer mouse (*Peromyscus maniculatus*). Deer mouse home ranges span from 0.08 to 0.12 ha (0.20 to 0.30 acres), based on studies in other western states (Bowers and Smith 1979). It is noteworthy that home ranges of these male Preble's mice tend to have considerable overlap, with some large home ranges nearly completely containing smaller ranges. Although the ranges indicate much spatial overlap, the temporal overlap (two males in the same locale at the same time) was much lower.

Habitat Characterization Results

Vegetation and physical measurements were made to describe some of the abiotic and biotic characteristics at successful trapping transects in new locations. Physical characteristics from the 1998 Preble's mouse capture locations in Rock Creek are presented in Table 7 and Figure 3. Vegetation measurements of species richness, herbaceous density, and cover were made. A total of 161 species of vascular plants were recorded on the four Preble's mouse transects that were characterized in Rock Creek during 1998. The number of species per transect ranged from 85 to 98, with 68 to 72 percent of the species observed on each transect being native (Table 8). The number of species per trap station averaged 36 across all four transects (Table 9).

Herbaceous density, a measure of horizontal vegetation cover or thickness of vegetation, varied greatly among the transects, ranging from a mean of approximately 38 percent cover to almost 92 percent cover (Table 9). The mean herbaceous density averaged approximately 65 percent across the four transects sampled in Rock Creek (Table 9). Tree and shrub canopy cover, as measured with a spherical densiometer, also varied considerably among the transects, ranging from means of 3 to 34 percent cover, with a mean canopy cover of 15 percent for all four locations (Table 9). The woody index value (a derived value—see Methods section) varied from 25 to 79 (mean = 46), and the herbaceous index value ranged from 47 to 74, with a mean of 64 (Table 9).

Discussion

Preble's mice were captured in Walnut Creek below the B-4 Dam (four males and one female, Table 3). This is noteworthy because no Preble's mice were captured there in 1997, although the trapping effort was limited and not during optimal seasons (K-H 1997b). These captures along this stretch of Walnut Creek document the continued existence of this Preble's mouse population.

The number of individuals captured in Rock Creek was relatively low compared to previous trapping (DOE 1995, K-H 1996a,b). These numbers were low enough to prohibit the calculation of a mark-recapture estimate for 1998. The reasons for the low capture rate were not determined but could result from a number of factors. Adding to the complexity of environmental factors that may have influenced capture success was evidence of trap shyness, such as 1) observations of uncollared (i.e., uncaptured) individuals during visual observations of collared individuals, 2) observations (through telemetry) of collared individuals in trapping transects apparently avoiding the traps, and 3) observations of individuals within trapping transects where they were not captured in traps. Recaptures were very low (only three). All these observations lead to a conclusion that there may have been many individuals missed during trapping. Therefore, the low number of captures in 1998 may not indicate low numbers, considering the fact that other mice in Rock Creek remained uncaptured despite the large trapping effort.

Researchers trapping Rock Creek in past years (K-H 1996a) typically trapped in areas most likely to yield Preble's mice. This is a biased approach and results in "hot spots." An unbiased approach to estimating the population in Rock Creek would randomly select locations to trap within all available habitat, not just the hot spots. This was the approach taken during 1998 trapping, and as one might expect, trapping results were lower because "hot spots" were not intentionally selected.

Telemetry studies at the Site were largely successful at answering the study questions. Great distances traveled over a 24-hour period, and large areas used during telemetry sessions, indicate a species that travels widely within appropriate habitat of Rock Creek. Travel distances reported on the basis of radio telemetry should be viewed with the associated uncertainty inherent in such estimates. The accuracy of point estimates should be interpreted as ±23 m (75.5 ft).

The upper two-thirds of Rock Creek (i.e., on the Site) is now viewed as one continuous reach of Preble's mouse habitat. This includes stream branches from the headwater areas downstream to about one-eighth of a mile downstream from the main confluence. Beyond that point, the streamside vegetation is quite sparse and dry, providing limited cover. The stream terraces are piled with cobblestones, and the stream channel is dry, evidencing none of the subirrigation found along other stream segments. These conditions continue downstream for another eighth of a mile until appropriate Preble's mouse habitat is present again. This dry, sparsely vegetated segment of Rock Creek may pose something of a barrier to movement between the upstream and downstream populations, but there is no evidence to indicate whether it is actually a barrier or not.

The understanding of the extent to which Preble's mice use areas away from the main creek channel has been greatly enhanced through the use of radio telemetry. In Rock Creek, individuals were radio-located up to 245 m (804 ft) in perpendicular distance from the stream channel. Additionally, a nest site and probable hibernation location were found in the seep shrubland (tall upland shrubland) community, 155 m (580 ft) away from the main stream channel. These observed distances may be extreme examples or may be typical only for seep-fed stream systems. However, it does speak to the need to consider large buffer areas away from streams, especially if these areas are seep-fed wetlands, as opposed to more typical streams flanked by grasslands.

Physical characteristic measurements from 1998 Preble's mouse capture locations (successful trap stations only) in Rock Creek were all within the range recorded previously (Table 7 and Figure 3). This was not unexpected, given that 1998 transects were located along stream channels and traplines were not laid out on grids extending into surrounding grasslands.

For data examined at the transect level, plant species richness averaged approximately 10 species more per trap station at the 1998 Rock Creek trap stations than was found during the 1997 sampling in Woman Creek (Table 9). Although a likely explanation might be that the species richness in Rock Creek is higher than in Woman Creek, an analysis of the 1997 high-value vegetation species richness inventory data from both Rock Creek and Woman Creek riparian corridors does not support this assumption. Woman Creek had a greater species richness (263 species) than Rock Creek (244 species). A comparison to 1996 species richness data from Preble's mouse trapping in lower Rock Creek revealed that successful capture locations there averaged only 27 species/trap station.

The herbaceous index values (a derived cover index) from Rock Creek in 1998 were lower than those found at successful and non-successful transects in Woman Creek in 1996 (Table 9). The differences, however, were minimal (only two or three index points) and do not suggest any real differences in herbaceous cover. The herbaceous density, tree/shrub cover, and woody index values from Rock Creek in 1998 fell between the values taken at successful and non-successful transects sampled along Woman Creek in 1997 (Table 9). The 1997 study in Woman Creek examined differences in vegetation parameters between successful transects (at least one Preble's mouse capture) and unsuccessful transects (no Preble's mouse captures; K-H 1998), with the hope of detecting vegetation differences that could be used to predict Preble's mouse distribution. Significant differences were found between successful and unsuccessful transects in 1997, which suggested that vegetation differences along the stream corridor could account for Preble's mouse presence or absence in an area. The 1998 data for these three measurements, being intermediate between the 1997 successful and unsuccessful transect values, reduces the previously held significance and broadens the ranges of values.

The significance of these vegetation differences is further reduced when telemetry movement data from the 1998 telemetry study in Rock Creek are considered. The 1998 telemetry data show that Preble's mice were present at both successful and unsuccessful

transect locations, but were simply not captured. Their presence at both successful and unsuccessful transects requires reexamination of previous vegetation measurements.

Given the wide range of vegetation parameters in which the mice are now known to occur on Site, and with the addition of the telemetry data that further expands their known occurrence in the riparian corridor at the Site, the definition of Preble's mouse habitat must again be revised. Based on current knowledge, the Preble's mouse could be found almost anywhere along the streams on the Site. Therefore, vegetation may not be the major limiting factor in their distribution on the Site. If vegetation is not a limiting factor, then factors limiting their distribution have yet to be identified. If there are barriers to movement, what constitutes a barrier will need to be defined. More data may be needed before the characteristics of a movement corridor can be defined.

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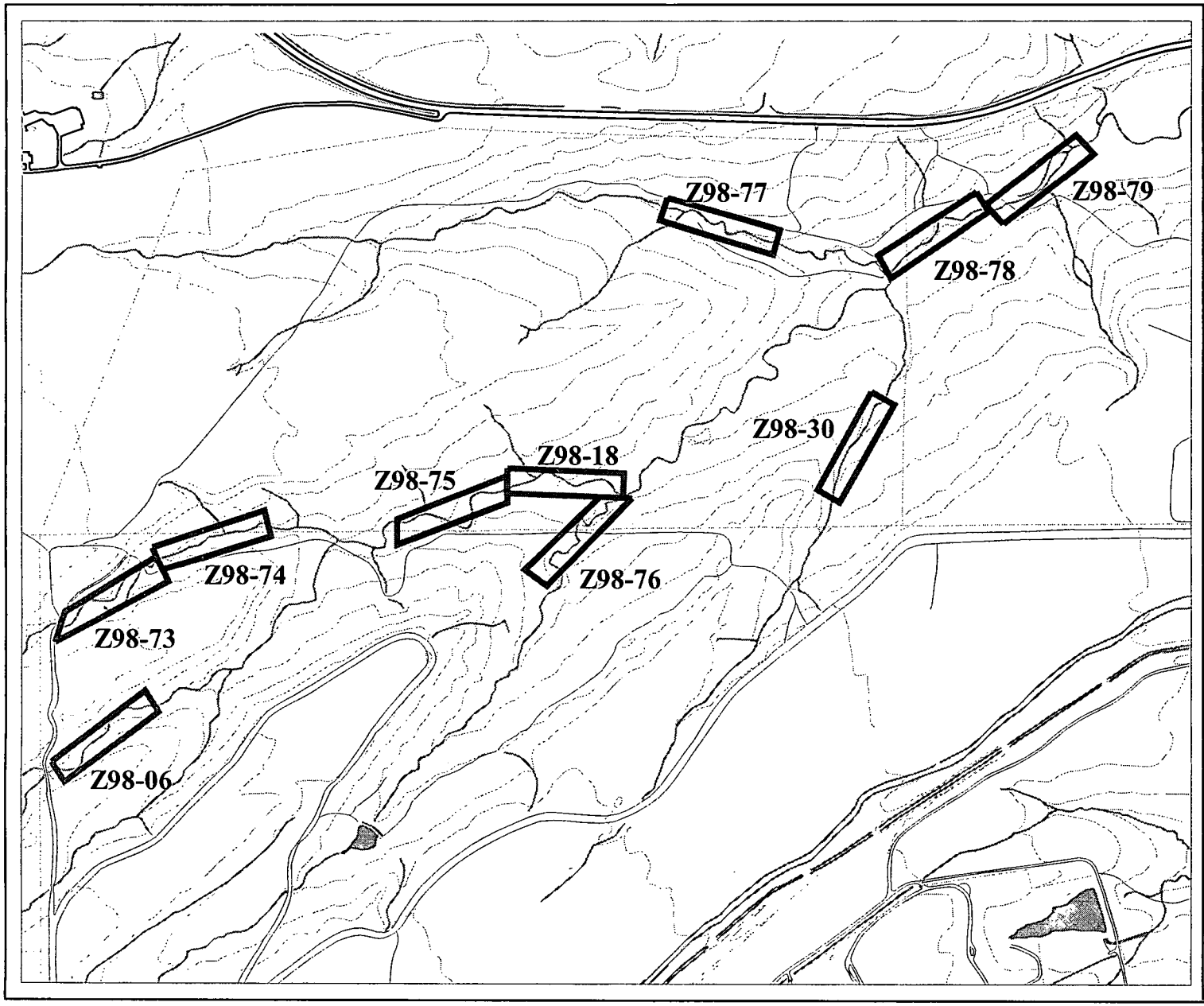

1998 Preble's mouse sampling sites, Rock Creek.

Figure 1.

MAP LEGEND

- 1998 Preble's sampling sites
- Paved roads
- Dirt roads
- Streams
- Contours (25 ft)
- Fences
- Ponds

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

1:11230

500 0 500 1000 Feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by: Exponent

For: Kaiser-Hill Company, LLC

MAP ID: mmf99-z98sites

April 21, 1999

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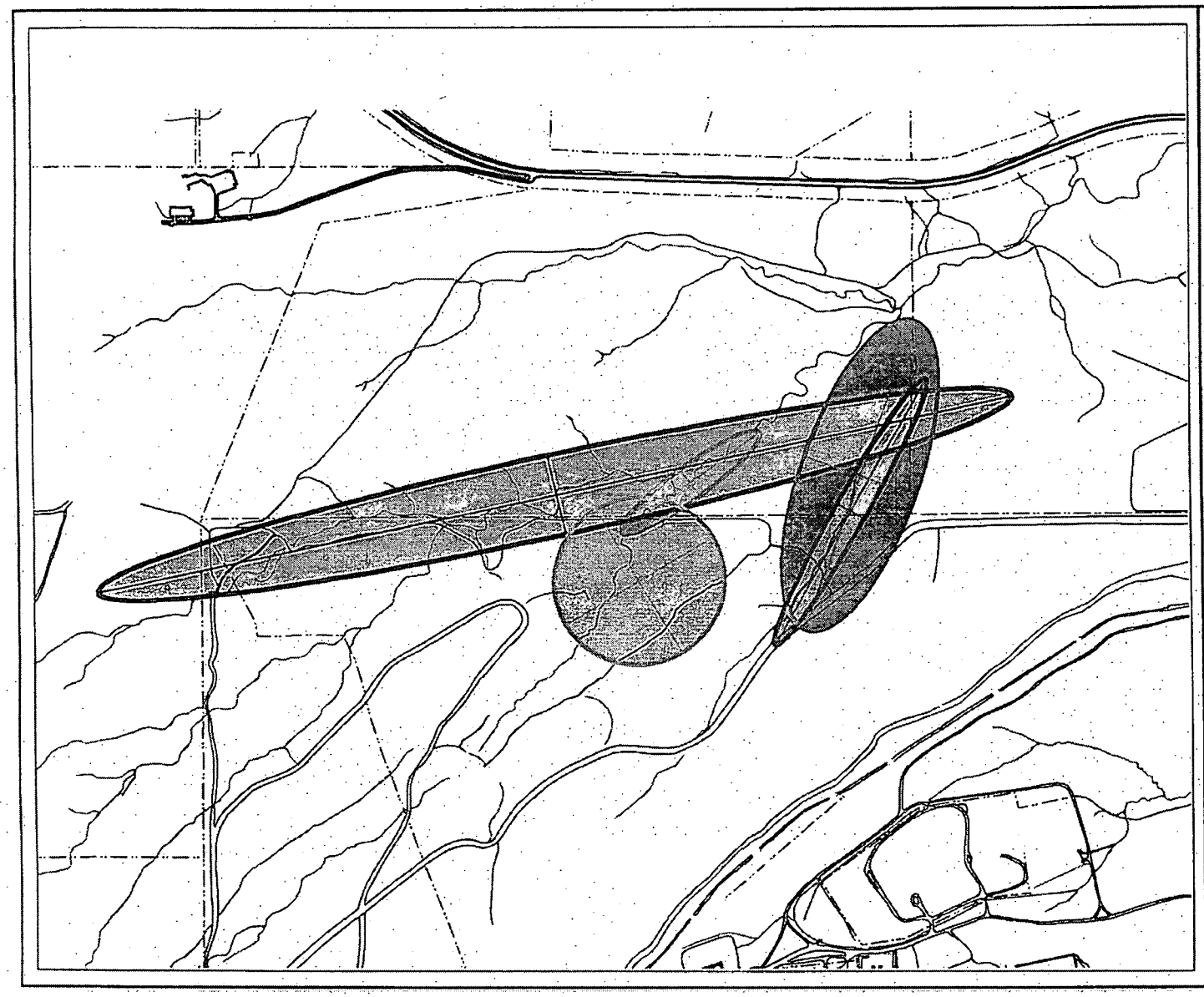

Jennrich-Turner home range estimation of collared Preble's meadow jumping mice using 90% probability ellipse.

Figure 2.

MAP LEGEND

Collar Frequency

- 172.311
- 172.391
- 172.493
- 172.515
- 172.562

Standard Map Features

- Dirt roads
- Paved Roads
- Streams
- Fences

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1997 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Hypsography derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~10 meter resolution.
The DEM post-processing performed by MK, Winter 1997.

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500 0 500 1000 Feet

Universal Transverse Mercator Projection
Zone 13
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

For: Kaiser-Hill Company, LLC

Map ID: mm99-PMJ/home

April 26, 1999

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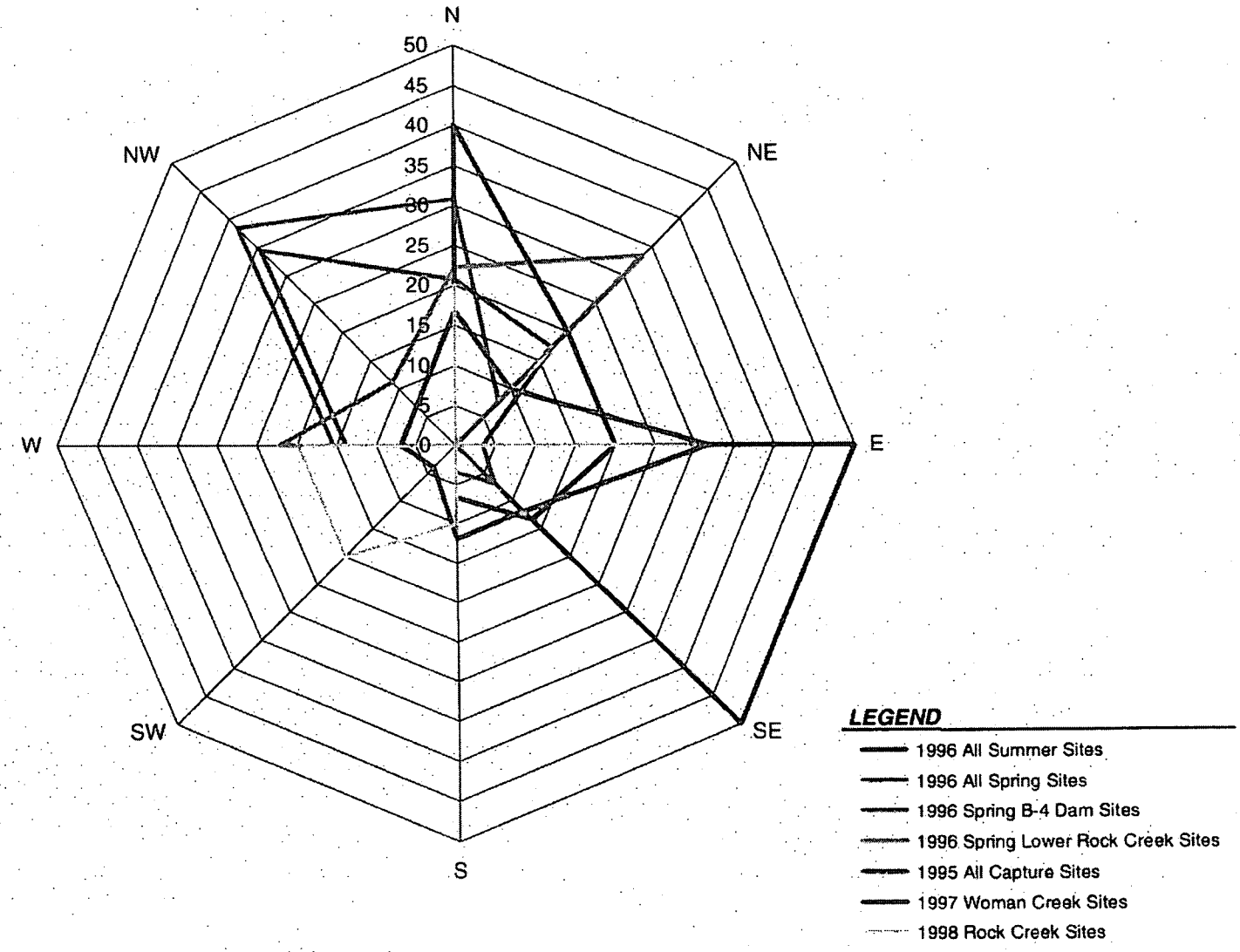

Figure 3. Summary of slope aspect measurements associated with Preble's mouse records, summer 1997, summer 1996 compared to spring 1996.

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TABLE 1. CAPTURE SUMMARY, PREBLE'S MOUSE TRAPPING IN ROCK AND WALNUT CREEKS, 1998

		Rock Creek		Walnut Creek		Total	
Species	Common Name	Number	Percent	Number	Percent	Number	Percent
Peromyscus maniculatus	Deer mouse	1,775	47.6%	120	49.8%	1,895	47.7%
Microtus pennsylvanicus	Meadow vole	1,910	51.2%	93	38.6%	2,003	50.4%
Reithrodontomys megalotis	Western harvest mouse	2	0.1%	1	0.4%	3	0.1%
Microtus ochrogaster	Prairie vole	17	0.5%	15	6.2%	32	0.8%
Zapus hudsonius	Preble's meadow jumping mouse	15	0.4%	5	2.1%	20	0.5%
Neotoma mexicana	Mexican woodrat	4	0.1%	2	0.8%	6	0.2%
Chaetodipus hispidus	Hispid pocket mouse	2	0.1%	5	2.1%	7	0.2%
Sorex cinereus	Masked shrew	5	0.1%	0	0.0%	5	0.1%
Not determined	Unknown rodent	1	0.0%	0	0.0%	1	0.0%
Total		3,731	100.0%	241	100.0%	3,972	100.0%

Note:

The first session for Walnut Creek trapping was from 2 June to 11 June (8 nights × 106 traps = 848 trap nights).
The second session for Walnut Creek trapping was from 9 September to 17 September (7 nights × 50 traps = 350 trap nights).
The first session for Rock Creek trapping was from 17 June to 2 July ((7 nights × 250 traps) + (7 nights × 250 traps) = 3,500 trap nights).
The second session for Rock Creek trapping was from 24 August to 11 September ((7 nights × 250 traps) + (7 nights × 250 traps) = 3,500 trap nights).
The total trapping effort (session 1 and 2) for Walnut Creek was 1,198 trap nights.
The total trapping effort (session 1 and 2) for Rock Creek was 7,000 trap nights.

TABLE 2. SESSION SUMMARY, PREBLE'S MOUSE TRAPPING IN ROCK AND WALNUT CREEKS, 1998

Species	Common Name	Rock Creek		Walnut Creek		Total	
		Number	Percent	Number	Percent	Number	Percent
First Session							
Peromyscus maniculatus	Deer mouse	953	59.2%	91	49.7%	1,044	58.3%
Microtus pennsylvanicus	Meadow vole	637	39.6%	73	39.9%	710	39.6%
Reithrodontomys megalotis	Western harvest mouse	1	0.1%	1	0.5%	2	0.1%
Microtus ochrogaster	Prairie vole	4	0.2%	14	7.7%	18	1.0%
Zapus hudsonius	Preble's meadow jumping mouse	10	0.6%	4	2.2%	14	0.8%
Neotoma mexicana	Mexican woodrat	1	0.1%	0	0.0%	1	0.1%
Chaetodipus hispidus	Hispid pocket mouse	0	0.0%	0	0.0%	0	0.0%
Sorex cinereus	Masked shrew	3	0.2%	0	0.0%	3	0.2%
Not determined	Unknown rodent	0	0.0%	0	0.0%	0	0.0%
Total		1,609	100.0%	183	100.0%	1,792	100.0%
Second Session							
Peromyscus maniculatus	Deer mouse	822	38.7%	29	50.0%	851	39.0%
Microtus pennsylvanicus	Meadow vole	1,273	60.0%	20	34.5%	1,293	59.3%
Reithrodontomys megalotis	Western harvest mouse	1	0.0%	0	0.0%	1	0.0%
Microtus ochrogaster	Prairie vole	13	0.6%	1	1.7%	14	0.6%
Zapus hudsonius	Preble's meadow jumping mouse	5	0.2%	1	1.7%	6	0.3%
Neotoma mexicana	Mexican woodrat	3	0.1%	2	3.4%	5	0.2%
Chaetodipus hispidus	Hispid pocket mouse	2	0.1%	5	8.6%	7	0.3%
Sorex cinereus	Masked shrew	2	0.1%	0	0.0%	2	0.1%
Not determined	Unknown rodent	1	0.0%	0	0.0%	1	0.0%
Total		2,122	100.0%	58	100.0%	2,180	100.0%

TABLE 3. PREBLE'S MEADOW JUMPING MOUSE (*Zapus hudsonius preblei*) CAPTURES AT THE SITE, 1998

		Rock Creek				Walnut Creek		Total			
		Adult		Juvenile		Adult		Adult			Grand
Session	Date	Male	Female	Male	Female	Male	Female	Male	Female	Juvenile	Total
First	6/2/98					1		1			
	6/3/98					1	1	1	1		
	6/11/98					1		1			
	6/19/98	2						2			
	6/25/98	2	1					2	1		
	6/26/98		1						1		
	7/1/98	2						2			
Second	9/1/98		1	1					1	1	
	9/2/98	1						1			
	9/9/98					1		1			
	9/10/98		1						1		
Totals		7	4	1	0	4	1	11	5	1	17

TABLE 4. PRIMARY AND SECONDARY HABITAT AVAILABLE TO PREBLE'S MICE WITHIN ROCK CREEK AND THE SITE

	Acres	
Vegetation Types	Rock Creek	Site[a]
Short upland shrub	15	39
Woodland riparian complex	6	42
Leadplant shrub	5	26
Total Major Habitats:	26	107
Short marsh	54	122
Tall upland shrub	32	34
Total Minor Habitats:	86	156

[a] Spatial extent of available habitat was calculated from the 1996 Site Vegetation Types Map.

TABLE 5. DENSITIES OF PREBLE'S MICE, 1994–1996[a]

Area and Number	Density (#/hectare)	Density (#/acre)	Year
Rock Creek (n=9)	26.1	10.6	1994
	21.7	8.8	1995
	8.8	3.6	1994
	26.5	10.7	1995
	26.7	10.8	1994
	13.3	5.4	1995
	13.7	5.5	1994
	21.4	8.7	1995
	13.7	5.5	1996
Rock Creek Average	19.1	7.7	
Walnut & Woman Creek (n=9)	12.5	5.1	1994
	21.9	8.9	1995
	18.5	7.5	1995
	22.2	9.0	1994
	16.7	6.8	1995
	1.0	0.4	1995
	36.3	14.7	1995
	25.3	10.2	1996
	1.0	0.4	1995
Walnut & Woman Creek Average	17.3	7.0	
Combined Average for the Site	**18.2**	**7.4**	

[a] Densities for Preble's mice from grid sampling in 1994, 1995, and 1996 (DOE 1995, K-Hill 1996a, b).

TABLE 6. CALCULATION OF UPPER BOUNDS OF PREBLE'S MOUSE POPULATIONS IN ROCK CREEK AND FOR THE SITE

	Total Available Habitat Types (acres)		Average Density	Population Estimate Based on:	
	Major	Minor	(#/acre)	Major Habitat	All Habitat
Rock Creek	26	86	7.7	200	862
Site	107	156	7.4	792	1,946

TABLE 7. MICROSITE HABITAT CHARACTERIZATION SUMMARY FOR PREBLE'S MOUSE HABITAT: SUMMER 1998, SUMMER 1997, SUMMER 1996, SPRING 1996, AND FALL 1995

Microsite Habitat Characterization Variables	Summer 1998	Summer 1997	Summer 1996	Spring 1996	Fall 1995
Slope angle (°)	2–48	2–10	2–26	1–40	1–65
Slope aspect	see Fig. 2	see Fig. 2	see Fig. 2	see Fig. 2	see Fig. 2
Slope position[a]	R,B	R,B	R	R, B, M	R, B, M
Distance to stream (m)	0.5–9.2 (2.0)	NA	0–0.5 (0.1)	0–25 (9.5)	0–35 (8.6)
Distance to embankment (m)	0–3.5 (2.2)	0.5–19.6 (7.0)	3–5.5 (3.9)	0–25 (8)	0–20 (4.1)
Distance to canopy edge (m)	0–52 (8.3)	0–0.5 (0.07)	0 (0.0)	0–15 (2.3)	0–73 (7.7)
Stem densities (stems/m^2)					
Symphoricarpos occidentalis	NA	1–4[b]	NA	6.61	3.1
Salix exigua	NA	3–5[b]	NA	1.61	2.89
Rosa arkansana	NA	1–3[b]	NA	0.7	0.91
Prunus virginiana	NA	2[b]	NA	0.2	0.47
Amorpha fruticosa	NA	1–4[b]	NA	0.17	0.59
Rhus aromatica	NA	2[b]	NA	0.12	0.02
Tree and shrub density distributions[c]					
Salix exigua	NA	5–8	7–8	NA	NA
Amorpha fruticosa	NA	3–8	4–7	NA	NA
Rosa arkansana	NA	2–5	4–5	NA	NA
Symphoricarpos occidentalis	NA	3–6	0–3	NA	NA
Prunus virginiana	NA	5	0–3	NA	NA
Populus deltoides	NA	3	NA	NA	NA
Salix amygdaloides	NA	1–5	NA	NA	NA
Rhus aromatica	NA	3	NA	NA	NA
Tree and shrub cover amounts[d]					
Salix exigua	NA	15–87.5 (61)	NA	NA	NA
Amorpha fruticosa	NA	1–37.5 (18)	NA	NA	NA
Rosa arkansana	NA	1–3 (0.67)	NA	NA	NA
Symphoricarpos occidentalis	NA	1–37.5 (6.23)	NA	NA	NA
Prunus virginiana	NA	3 (0.2)	NA	NA	NA
Populus deltoides	NA	15 (1.0)	NA	NA	NA
Salix amygdaloides	NA	0.5–37.5 (5.76)	NA	NA	NA

TABLE 7. (cont.)

Microsite Habitat Characterization Variables	Summer 1998	Summer 1997	Summer 1996	Spring 1996	Fall 1995
Tree and shrub canopy cover (%)	NA	NA	100[e]	47–68	70
Tree and shrub canopy cover (%)[f]		0–83 (41)	22–91 (75)	NA	NA
Herbaceous density		69–94 (85)	92–98 (95)	NA	NA
Herbaceous canopy cover (%)	NA	NA	0[e]	32–53	30
Tree canopy (%)	0 (0)	0–87.5 (29.5)[d]	NA	0–40 (2.2)	0–70 (10.8)
Shrub canopy (%)	0–87.5 (27.1)	3–87.5 (45.7)[d]	NA	10–100 (51)	0–80 (46.8)
Sub-shrub canopy (%)	0–62.5 (14.1)	0–37.5 (6.5)[d]	NA	NA	NA
Forb cover (%)	15–62.5 (26.5)	1–87.5 (28.7)[d]	NA	NA	NA
Graminoid cover (%)	3–87.5 (35.1)	1–87.5 (31.1)[d]	NA	NA	NA
Soil cover (%)	NA	0.5–37.5 (14.1)[d]	NA	NA	NA
Rock cover (%)	NA	0.5–87.5 (12.1)[d]	NA	NA	NA
Water cover (%)	NA	0–15 (8.4)[d]	NA	NA	NA
Basal vegetation cover (%)	NA	3–37.5 (19.4)[d]	NA	NA	NA
Foliar canopy (%)	NA	NA	37.5–62.5 (50)[d]	30–90 (65.3)	30–80 (49.3)
Litter cover (%)[d]	NA	1–87.5 (37.6)[d]	37.5–62.5 (56.25)	NA	NA
Tree heights (m)	NA	1.5–11.9 (3.77)	11.5–12.3 (11.9)	NA	NA
Shrub heights (m)	NA	0.63–2.80 (1.68)	1.0–2.2 (1.9)	NA	NA
Sub-shrub heights (m)	NA	0.25–1.03 (.65)	0.3–0.8 (0.6)	NA	NA

Numbers in ( ) = Mean.
NA = Not available.

[a] R=Riparian, B=Bottom, M=Middle Slope.

[b] Measured using a stem density class system. Previously, actual counts were made.

[c] Density distributions were measured using a density distribution class system.

[d] Measured using cover class system. Previously measured based on visual estimate.

[e] Because all of the capture locations were under the canopy of the trees and shrubs, there was no herbaceous canopy cover.

[f] Measured with spherical crown densiometer in summer 1996. Previously measured based on visual estimate.

Spring 1996 data (K-Hill 1996b).
Fall 1995 data (K-Hill 1996c).

TABLE 8. 1998 PREBLE'S MOUSE ROCK CREEK CAPTURE TRANSECT VEGETATION SPECIES RICHNESS LIST

Family	Scientific Name	Site			
		9830A	9875A	9876A	9877B
ALISMATACEAE	*Alisma trivale Pursh*	X		X	
ALISMATACEAE	*Sagittaria latifolia Willd.*	X		X	
ANACARDIACEAE	*Rhus aromatica Ait. var. trilobata (Nutt.) A. Gray*	X	X		X
ANACARDIACEAE	*Toxicodendron rydbergii (Small) Greene*	X			
APIACEAE	*Cicuta maculata L. var. angustifolia Hook.*		X	X	
APIACEAE	*Heracleum sphondylium L. ssp. montanum (Schleich.) Briq.*		X		
ASCLEPIADACEAE	*Asclepias incarnata L.*	X			
ASCLEPIADACEAE	*Asclepias speciosa Torr.*	X	X	X	X
ASTERACEAE	*Achillea millefolium L. ssp. lanulosa (Nutt.) Piper*	X	X	X	X
ASTERACEAE	*Ambrosia psilostachya DC.*	X	X		X
ASTERACEAE	*Arctium minus Bernh.*	X		X	
ASTERACEAE	*Artemisia frigida Willd.*	X			
ASTERACEAE	*Artemisia ludoviciana Nutt. var. ludoviciana*		X	X	X
ASTERACEAE	*Aster falcatus Lindl.*	X	X	X	X
ASTERACEAE	*Aster hesperius A. Gray var. hersperius*	X		X	
ASTERACEAE	*Bidens frondosa L.*	X			X
ASTERACEAE	*Carduus nutans L. ssp. macrolepis (Peterm.) Kazmi*	X	X	X	X
ASTERACEAE	*Centaurea diffusa Lam.*	X	X		X
ASTERACEAE	*Chrysopsis villosa Pursh.*		X		
ASTERACEAE	*Cirsium arvense (L.) Scop.*	X	X	X	X
ASTERACEAE	*Cirsium vulgare (Savi) Ten.*	X			X
ASTERACEAE	*Erigeron divergens T. & G.*				X
ASTERACEAE	*Erigeron flagellaris A. Gray*				X
ASTERACEAE	*Grindelia squarrosa (Pursh.) Dun.*	X	X	X	X
ASTERACEAE	*Gutierrezia sarothrae (Pursh.) Britt. & Rusby*	X		X	X
ASTERACEAE	*Helianthus nuttallii T. & G.*		X		
ASTERACEAE	*Lactuca serriola L.*	X	X	X	X
ASTERACEAE	*Liatris punctata Hook.*				X
ASTERACEAE	*Microseris cuspidata (Pursh.) Sch. Bip.*		X		
ASTERACEAE	*Ratibida columnifera (Nutt.) Woot. & Standl.*	X	X	X	X
ASTERACEAE	*Scorzonera laciniata L.*				X
ASTERACEAE	*Solidago gigantea Ait.*	X	X		
ASTERACEAE	*Solidago missouriensis Nutt.*	X	X	X	X
ASTERACEAE	*Solidago rigida L.*				X
ASTERACEAE	*Sonchus arvensis L. ssp. arvensis L.*				X
ASTERACEAE	*Taraxacum officinale Weber*			X	
ASTERACEAE	*Tragopogon dubius Scop.*	X		X	X
BORAGINACEAE	*Cynoglossum officinale L.*	X	X		
BORAGINACEAE	*Onosmodium molle Michx. var. occidentale (Mack.) Johnst.*	X			X
BRASSICACEAE	*Alyssum alyssoides (L.) L.*		X		
BRASSICACEAE	*Alyssum minus (L.) Rothmaler var. micranthus (C. A. Mey.) Dudley*		X	X	X
BRASSICACEAE	*Barbarea vulgaris R. Br.*	X	X	X	X
BRASSICACEAE	*Camelina microcarpa Andrz. ex DC.*				X
BRASSICACEAE	*Descurainia pinnata (Walt.) Britt.*	X			
BRASSICACEAE	*Descurainia richardsonii (Sweet) Schultz*	X		X	
BRASSICACEAE	*Nasturtium officinale R. Br.*	X	X	X	X
BRASSICACEAE	*Physaria vitulifera Rydb.*		X		
BRASSICACEAE	*Thlaspi arvense L.*	X		X	
CACTACEAE	*Opuntia macrorhiza Engelm.*		X		X
CAPRIFOLIACEAE	*Symphoricarpos occidentalis Hook.*	X	X	X	X
CARYOPHYLLACEAE	*Cerastium arvense L.*				X
CARYOPHYLLACEAE	*Cerastium vulgatum L.*	X			
CHENOPODIACEAE	*Chenopodium album L.*	X		X	
CLUSIACEAE	*Hypericum perforatum L.*	X	X	X	
CYPERACEAE	*Carex brevior (Dew.) Mack. ex Lunell.*				X
CYPERACEAE	*Carex hystericina Muhl. ex Willd.*		X		X

TABLE 8. (cont.)

Family	Scientific Name	Site			
		9830A	9875A	9876A	9877B
CYPERACEAE	*Carex interior Bailey*		X		
CYPERACEAE	*Carex lanuginosa Michx.*	X			
CYPERACEAE	*Carex nebrascensis Dew.*	X	X	X	X
CYPERACEAE	*Carex praegracilis W. Boott.*		X		X
CYPERACEAE	*Carex scoparia Schkuhr. ex Willd.*		X		
CYPERACEAE	*Carex stipata Muhl.*	X			X
CYPERACEAE	*Eleocharis macrostachya Britt.*	X	X	X	X
CYPERACEAE	*Scirpus pallidus (Britt.) Fern*	X	X	X	X
CYPERACEAE	*Scirpus pungens Vahl*				X
CYPERACEAE	*Scirpus validus Vahl.*	X	X		X
EQUISETACEAE	*Equisetum laevigatum A. Br.*		X		X
FABACEAE	*Amorpha fruticosa L.*		X	X	
FABACEAE	*Dalea purpurea Vent*				X
FABACEAE	*Glycyrrhiza lepidota Pursh.*	X		X	X
FABACEAE	*Lathyrus eucosmus Butters and St. John*	X	X		X
FABACEAE	*Lupinus argenteus Pursh var. argenteus*	X	X		
FABACEAE	*Medicago lupulina L.*		X		X
FABACEAE	*Melilotus alba Medic.*		X		
FABACEAE	*Melilotus officinalis (L.) Pall.*		X		
FABACEAE	*Psoralea tenuiflora Pursh.*	X	X	X	X
FABACEAE	*Thermopsis rhombifolia var. divaricarpa (Nels.) Isely*	X	X	X	
FABACEAE	*Trifolium sp.*			X	X
FABACEAE	*Vicia americana Muhl. ex Willd.*				X
GERANIACEAE	*Geranium caespitosum James ssp. caespitosum*	X	X	X	X
GROSSULARIACEAE	*Ribes aureum Pursh*	X			
HYDROPHYLLACEAE	*Hydrophyllum fendleri (Gray) Heller*	X			
JUNCACEAE	*Juncus balticus Willd.*	X	X	X	X
JUNCACEAE	*Juncus dudleyi Wieg.*	X	X	X	X
JUNCACEAE	*Juncus ensifolius Wikst. var. montanus (Englm.) C. L. Hitchc.*		X		
JUNCACEAE	*Juncus nodosus L.*	X	X	X	X
JUNCACEAE	*Juncus torreyi Cov.*	X			
LAMIACEAE	*Lycopus americanus Muhl. ex Barton*	X	X	X	X
LAMIACEAE	*Mentha arvensis L.*	X	X	X	X
LAMIACEAE	*Monarda fistulosa L. var. menthifolia (Grah.) Fern.*		X	X	X
LAMIACEAE	*Nepeta cataria L.*	X	X	X	X
LAMIACEAE	*Prunella vulgaris L.*	X	X	X	X
LEMNACEAE	*Lemna minor L.*	X	X	X	
LILIACEAE	*Smilacina stellata (L.) Desf.*	X		X	X
LINACEAE	*Linum perenne L. var. lewisii (Pursh.) Eat. & Wright*	X			
MALVACEAE	*Sphaeralcea coccinea (Pursh.) Rydb.*		X		X
ONAGRACEAE	*Epilobium ciliatum Raf. ssp. glandulosum (Lehm.) Hock & Raven*	X	X	X	X
ONAGRACEAE	*Epilobium paniculatum Nutt.*	X		X	X
ONAGRACEAE	*Gaura parviflora Dougl.*			X	
ONAGRACEAE	*Oenothera villosa Thunb. ssp. strigosa (Rydb.) Dietrich & Raven*	X	X	X	X
OXALIDACEAE	*Oxalis dillenii Jacq.*		X	X	
PLANTAGINACE	*Plantago major L.*				X
POACEAE	*Agropyron repens (L.) Beauv.*	X	X	X	X
POACEAE	*Agropyron smithii Rydb.*	X	X	X	X
POACEAE	*Agrostis scabra Willd.*	X			
POACEAE	*Agrostis stolonifera L.*	X	X	X	X
POACEAE	*Aristida purpurea Nutt. var. robusta (Merrill) A. Holmgren & N. Holmgr*		X		X
POACEAE	*Bouteloua curtipendula (Michx.) Torr.*		X		
POACEAE	*Bouteloua gracilis (H. B. K.) Lag ex Griffiths*		X		X
POACEAE	*Bromus inermis Leyss. ssp. inermis*		X		X
POACEAE	*Bromus japonicus Thunb. ex Murr.*	X	X	X	X
POACEAE	*Bromus tectorum L.*		X	X	

TABLE 8. (cont.)

Family	Scientific Name	Site 9830A	9875A	9876A	9877B
POACEAE	*Buchloe dactyloides (Nutt.) Engelm.*				X
POACEAE	*Dactylis glomerata L.*				X
POACEAE	*Elymus canadensis L.*	X	X	X	
POACEAE	*Festuca pratensis Huds.*	X			X
POACEAE	*Glyceria grandis S. Wats. ex A. Gray*			X	
POACEAE	*Glyceria striata (Lam.) Hitchc.*	X	X	X	X
POACEAE	*Hordeum jubatum L.*			X	
POACEAE	*Koeleria pyramidata (Lam.) Beauv.*	X		X	X
POACEAE	*Leersia oryzoides (L.) Sw.*	X		X	
POACEAE	*Phleum pratense L.*		X		X
POACEAE	*Poa compressa L.*	X	X	X	X
POACEAE	*Poa palustris L.*	X	X	X	
POACEAE	*Poa pratensis L.*	X	X	X	X
POACEAE	*Sporobolus asper (Michx.) Kunth*				X
POACEAE	*Stipa comata Trin. & Rupr.*		X		
POACEAE	*Stipa viridula Trin.*	X	X		X
POLYGONACEAE	*Polygonum convolvulus L.*	X		X	X
POLYGONACEAE	*Polygonum hydropiper L.*	X			
POLYGONACEAE	*Polygonum lapathifolium L.*				X
POLYGONACEAE	*Polygonum pensylvanicum L.*		X		
POLYGONACEAE	*Polygonum persicaria L.*	X		X	
POLYGONACEAE	*Polygonum ramosissimum Michx.*			X	
POLYGONACEAE	*Rumex crispus L.*	X	X	X	X
POLYGONACEAE	*Rumex maritimus L.*	X			
POLYGONACEAE	*Rumex obtusifolius L.*		X		
RANUNCULACEAE	*Ranunculus macounii Britt.*	X	X	X	
ROSACEAE	*Crataegus erythropoda Ashe*	X	X	X	
ROSACEAE	*Geum aleppicum Jacq.*		X	X	
ROSACEAE	*Geum macrophyllum Willd.*	X	X	X	X
ROSACEAE	*Potentilla gracilis Dougl. ex Hook. var. glabrata (Lehm.) C. L. Hitchc.*			X	
ROSACEAE	*Potentilla norvegica L.*			X	
ROSACEAE	*Prunus americana Marsh.*		X	X	
ROSACEAE	*Prunus virginiana L. var. melanocarpa (A. Nels.) Sarg.*	X	X	X	X
ROSACEAE	*Rosa arkansana Porter*	X	X	X	X
ROSACEAE	*Rosa woodsii Lindl.*	X	X	X	X
RUBIACEAE	*Galium aparine L.*	X	X	X	X
RUBIACEAE	*Galium septentrionale Roemer & Schultes*			X	
SALICACEAE	*Salix amygdaloides Anderss.*		X		
SALICACEAE	*Salix exigua Nutt. ssp. interior (Rowlee) Cronq.*		X		X
SALICACEAE	*Salix irrorata Andersson*		X		
SCROPHULARIACEAE	*Penstemon virgatus Gray ssp. asa-grayi Crosswhite*		X		
SCROPHULARIACEAE	*Verbascum blattaria L.*	X			X
SCROPHULARIACEAE	*Verbascum thapsus L.*	X	X	X	X
SCROPHULARIACEAE	*Veronica anagallis-aquatica L.*	X	X	X	X
SOLANACEAE	*Physalis heterophylla Nees*		X		
TYPHACEAE	*Typha angustifolia L.*	X		X	
TYPHACEAE	*Typha latifolia L.*	X	X	X	
VERBENACEAE	*Verbena hastata L.*	X	X	X	X
VIOLACEAE	*Viola sororia Willd.*	X			
		96	98	85	93
		72	71	69	68

TABLE 9. 1997 AND 1998 PREBLE'S MOUSE HABITAT CHARACTERIZATION PARAMETERS

Year:	1998					1997										
						Successful					Non-Successful					
Sample Site:	9830A	9875A	9876A	9877B	Overall	9772A	9768A	9767A	9771A	Overall	9764A	9769A	9765A	9770A	9766A	Overall
S or NS:	S	S	S	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	NS
Parameters	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄	x̄
# Species/trapsite	41.20	35.80	31.90	36.80	36.43	20.10	29.90	23.90	32.40	26.58	27.90	24.50	29.00	20.20	27.50	25.82
Herbaceous density	58.18	91.95	72.80	37.58	65.13	81.80	79.63	83.08	43.08	71.90	31.60	48.63	66.95	71.40	35.28	50.77
Tree/shrub canopy	10.09	34.22	12.48	2.70	14.87	23.76	14.40	58.40	0.21	24.19	0.99	2.94	34.55	12.01	0.00	10.10
Woody index value	30.35	79.00	48.35	25.40	45.78	79.85	71.95	85.25	29.20	66.56	6.10	15.60	78.95	44.10	8.75	30.70
Herbaceous index value	62.10	47.40	74.25	72.00	63.94	75.15	49.20	50.10	92.80	66.81	101.70	47.15	56.25	27.15	93.05	65.06
Tree cover	0.00	3.20	8.75	0.00	2.99	30.75	3.00	47.75	0.10	20.40	0.30	4.50	26.85	0.05	0.00	6.34
Shrub cover	13.70	72.50	14.80	15.50	29.13	40.85	65.00	34.55	25.30	41.43	0.35	11.10	46.80	43.25	0.05	20.31
SubShrub cover	16.65	3.30	24.80	9.90	13.66	8.25	3.95	2.95	3.80	4.74	5.45	0.00	5.30	0.80	8.70	4.05
Graminoid cover	26.60	24.35	45.50	50.25	36.68	42.85	34.80	24.90	63.10	41.41	80.00	42.95	36.00	24.20	72.50	51.13
Forb cover	35.50	23.05	28.75	21.75	27.26	32.30	14.40	25.20	29.70	25.40	21.70	4.20	20.25	2.95	20.55	13.93

Note: All values are means.
For each transect, n = 10.
S = Successful site.
NS = Non-successful site.

Attachment A

Habitat Characterization Information

TABLE A-1. HABITAT ENDPOINTS AND METHODS

Endpoints	Variables	Methods
Slope angle	0-90 degrees	Clinometer
Slope aspect	360 degrees	Compass
Slope position	P, T, U, M, B, R	Visual estimate
Moisture gradient	Hydric, humic, mesic, xeric	Visual estimate
Distance to stream (m)	Trap to stream edge	Meter tape
Distance to canopy edge (m)	Nearest contiguous riparian canopy does not include snowberry, rose, or shunkbush sumac	Meter tape
Habitat types	Primary, secondary, tertiary, quarternary	Use habitat codes
Trap canopy position	In, out, edge	Visual estimate
Tree and shrub canopy cover	Percent of closure (100=closed)	Spherical crown densiometer
Tree canopy species	Species code	RFETS codes
Shrub canopy species	Species code	RFETS codes
Herbaceous vertical density	Portion of m2 grid	Vegetation board
Foliar cover	Percent for tree, shrub, subshrub, grass, forb	Cover classes
Soil condition	Cobbly, gravelly, sandy, loamy, silty, clayey	Visual estimate

TABLE A-2. PERCENT COVER CLASSES

r	Solitary, with small cover
+	Few, with small cover
1	Numerous, <5% cover
2	5-25%
3	26-50%
4	51-75%
5	>75%

Attachment B

Explanation of Habitat Characterization Measures

TABLE B-1. PERCENT COVER CLASSES

r	solitary, with small cover
+	few, with small cover
1	numerous, < 5% cover
2	5-25%
3	26-50%
4	51-75%
5	>75%

TABLE B-2. STEM DENSITY CLASSES

0	0 stems per plot
1	1 to 10 stems per plot
2	11 to 50 stems per plot
3	51 to 100 stems per plot
4	101 to 200 stems per plot
5	201+ stems per plot

TABLE B-3. TRAP STATION HABITAT ENDPOINTS

ENDPOINTS	VARIABLES	METHODS
Slope Angle	0-90 degrees	Clinometer
Slope Aspect	360 degrees	Compass
Slope Position	P, T, U, M, B, R	See Figure B-2.
Moisture Gradient	Hydric, Humic, Mesic, Xeric	
Distance to Stream (m)	Trap to stream edge	meter tape
Distance to Embankment (m)	Other than stream bank	meter tape
Distance to Canopy Edge (m)	nearest contiguous riparian canopy does not include snowberry, rose, or skunkbush sumac	
Habitat Types	Primary, Secondary, Tertiary, Quarternary use Habitat Codes	
Trap Canopy Position	In, Out, Edge	
Tree and Shrub Canopy Cover	Percent of Closure (100=closed)	Spherical Crown Densiometer
Tree Canopy Species	Species Code	Site Codes
Shrub Canopy Species	Species Code	Site Codes
Tree Canopy Heights	Mean of 5 measures	Clinometer
Shrub Canopy Heights	Mean of 5 measures	Clinometer (or meter stick)
Subshrub Heights	Mean of 5 measures	Meter stick
Stem Densities	Stem Density Class for each shrub species	See Table B-2.
Stem Density Distribution	Density Distribution Class for each shrub species	See Figure B-1.
Herbaceous Vertical Density	Portion of square meter grid	Vegetation Board
Foliar Cover	Cover Classes	
Foliar Canopy Species	Species Code	Site Codes
Ground Cover	Cover Classes of: soil, rock, litter, grass, forb, shrubs, trees	
Soil Condition	Cobbly, Gravelly, Sandy, Loamy, Silty, Clayey	
Borrowing Opportunities	Low, Medium, High	

TABLE B-4. HABITAT TYPE DESCRIPTIONS USED IN 1996 SITE VEGETATION MAP

000 Aquatic and Wetlands Habitats Group

Terrestrial Subgroup

010 Wet Meadow/Marsh Ecotone

Typified by the presence of *Agrostis stolonifera*, *Spartina pectinata*, or occasionally solid stands *of Poa compressa* or *Agropyron smithii*. Other common plants found in this classification type include *Asclepias speciosa*, *Iris missouriensis*, *Cirsium arvense*, *Rumex* sp., and sometimes *Arnica fulgens*. Soils are usually fine, silty materials with few rocks. These areas are commonly found on the edges of the streams, ponds, seeps, and other wetter areas on Site, often just beyond the short marsh and tall marsh classifications.

020 Short Marsh

Typified by stands of *Carex* sp. and/or *Juncus* sp. This classification is usually wet and underwater for parts of the year. It has fine, muddy soils with few rocks. This classification is predominant in the wetlands at the Site.

030 Tall Marsh

Typified by stands of *Typha* sp. and/or *Scirpus* sp. These areas are usually underwater and have generally fine, muddy soils with few rocks. This classification is predominant in the wetlands at the Site.

Open Water Subgroup

050 Ponds and Impoundments

054 Open Water

This classification was used for the ponds and other open water bodies on Site.

Emergent Subgroup

090 Mudflats

This classification represents areas that often become exposed between the high and low water marks along the pond margins. It also includes small pool areas that completely dry out during the summer. Vegetation is usually sparse, but may include such species as *Echinochloa crusgallii*, *Rumex* sp., *Polygonum* sp., or a few other grasses or sedges.

100 Woodlands Habitat Group

110 Riparian Woodland

This classification is typified by stands of *Populus deltoides*, *Salix amygdaloides*, *Ulmus pumila*, *Populus albus*, and perhaps a few other tree species. There may also be an understory of *Prunus* sp., *Symphoricarpos* sp., *Salix* sp., or other woody species. This classification is found primarily along the drainage bottoms on Site.

120 Ponderosa Woodland

Typified by scattered stands of *Pinus ponderosa* with some occasional *Psuedotsuga menziesii*. This classification is found primarily on the western edge of the Site on the northern edges of ridgetops. It is also common along the old railroad grade. It is often surrounded by xeric mixed grassland.

130 Tree Plantings

This classification represent areas where trees have been planted for landscaping or shelterbelt purposes. The only location of this classification in the buffer zone in the apple orchard. Areas of this classification are present in the Industrial Area, but no vegetation mapping was done in this area for this map.

200 Shrublands Habitats Group

210 Riparian Shrubland

This classification is composed of stands of *Salix exigua* and/or *Amorpha fruticosa*. It is found primarily along the stream channels at the Site. This classification was broken down into two other subdivisions dependent on which species was dominant.

211 Riparian Shrubland - Stands dominated by *Amorpha fruticosa*.

212 Riparian Shrubland - Stands dominated by *Salix exigua*.

220 Short Upland Shrubland

This classification is dominated by stands of *Symphoricarpos occidentalis* and occasionally *Rosa* sp. This classification is typically found in a wetter environment than the Savannah Shrubland habitat described below. The short upland shrub is often found in association with wet meadows and other aquatic/riparian/wetland classifications.

230 Tall Upland Shrubland

This classification is typified by stands of *Crataegus erythropoda*, *Prunus virginiana*, and *Prunus americana*. Most of this classification is found on north facing slopes in the Rock Creek drainage. It is typically underlain by cobbly, gravely soils.

260 Savannah Shrubland

This classification represents areas of open shrubland with grassland between the scattered shrubs. The predominant shrub for this classification is *Rhus aromatica*, but occasionally *Ribes* ssp. and some other woody species may be present. Most of this classification is found in the Rock Creek drainage on Site.

300 Grasslands Habitats Group

310 Short Grassland

This classification is typified by stands short grass prairie species, *Buchloe dactyloides* and *Bouteloua gracilis*. Very little of this classification is found at the Site.

320 Mixed Grassland

This classification is broken down into three subdivisions found on the Site, which often intermix making boundary deliniations difficult between the classification types.

322 Mesic Mixed Grassland

This classification is typified dominated by *Agropyron smithii*, *Poa pratensis*, and *Bouteloua gracilis*. Other common species include *Stipa viridula*, *Poa compressa*, *Bromus japonicus*, and *Alyssum minus*. These grasslands have more of a solid turf appearance due to the physiognomy of the species present. This is in contrast to the bunchgrass appearance of the xeric mixed grassland described below. The soils are considered to be clay loams and do not have the cobbly appearance at the surface that is typical of the xeric mixed grassland soils. Most of the hillsides on the Site are considered mesic mixed grassland. The quality of these grasslands varies considerably across the Site. The mesic mixed grasslands on the western side of the Site seem to have been less impacted and degraded by exotic, alien invaders such as *Bromus japonicus*, *Alyssum minus*, and *Carduus nutans*, than those on the eastern edge of the site. For classification purposes no distinctions were made based on the impact of these exotics. As long as an understory of *Agropyron smithii*, *Poa pratensis*, or *Bouteloua gracilis* was present beneath the exotic, alien species the grassland was still classified as mesic mixed grassland.

323 Xeric Mixed Grassland

This classification is dominated by *Andropogon gerardii*, *Andropogon scoparius*, *Stipa comata*, *Muhlenbergia montana*, *Carex heliophila*, *Arenaria fendleri*, *Aster porteri*, *Koleria pyrimidata*, and *Liatris punctata*. The grassland has a bunchgrass appearance due to the physiognomy of the species present. Stands of *Yucca glauca* which are found in a few spots primarily on ridgetops on the eastern side of the Site are also included in the xeric mixed grassland classification because they are often surrounded and intermixed with this classification type. This classification is found on nearly all the pediments and ridgetops on Site and is underlain by Rocky Flats Alluvium. The soils are considered to be sandy clay loams with lots of cobbles. The surface of the ground is usually very rocky. Two subdivisions of xeric mixed grassland were recognized.

331 Xeric Tallgrass Prairie

This subdivision is dominated by *Andropogon gerardii* and *Andropogon scoparius*. It also contains high cover of *Muhlenbergia montana*, *Carex heliophila*, *Arenaria fendleri*, and *Aster porteri*. Other tallgrass prairie species include *Sorghastrum nutans*, *Sporobolus heterolepis*, and *Panicum virgatum*. The soils are usually visibly cobbly on the surface.

332 Xeric Needle and Thread Grass Prairie

This subdivision is dominated by *Stipa comata and Stipa neomexicana*. It contains very little *Andropogon gerardii* and *Andropogon scoparius*. The soils are not quite as visibly cobbly as the Xeric Tallgrass Prairie classification.

324 Reclaimed Mixed Grassland

This classification is dominated by *Bromus inermis*, *Agropyron intermedium*, *Agropyron cristatum*, *Melilotus* sp., *Convolvulus arvensis*, and other planted or adventive species. This classification covers all areas that have been previously been farmed or disturbed, and then revegetated with various seed mixtures. Large tracts of this habitat type are found in the southeastern portion of the Site and in and around the Industrial Area.

400 Disturbance Habitat Group

410 Annual Grass/Forb

This classification is dominated by a plant community of annuals such as *Bromus japonicus*, *Bromus tectorum*, *Centaurea diffusa*, *Helianthus annus*, and other associated species. This category was used when little or no mesic mixed grassland community existed beneath the annual species listed above. These areas were often disturbed, unrevegetated areas or areas where reclamation efforts had failed and an annual, early successional stage had established.

420 Disturbed /Barren Lands (Roads)

This classification was used for the roads and Industrial Area and other disturbed barren areas.

500 Structures and Structure Associations Habitats Group

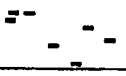
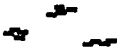
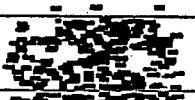
530 Rock and Gravel Piles

This classification was used for rip/rap piles along stream channels and on dam faces.

Table B-5. Wetland Indicator Codes and Meanings

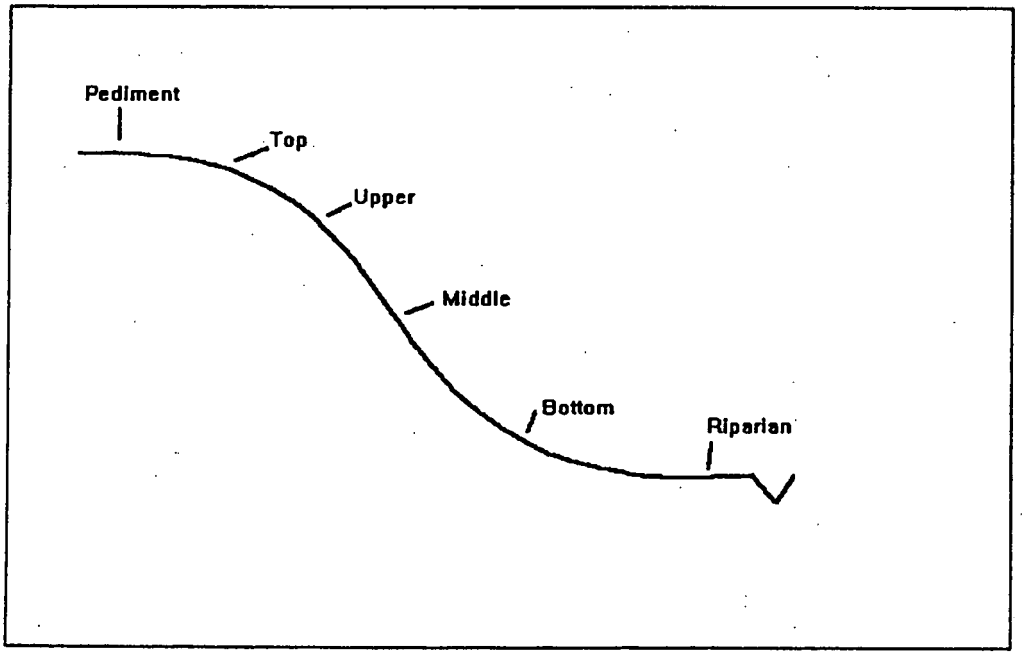
Code	Meaning
Blank	No information listed on species in USFWS wetland list.
FACU	Facultative Upland (FACU). Usually occur in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).
OBL	Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.
FACW	Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
NI	No indicator - not enough information to make a good determination.
FAC	Facultative (FAC). Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
UPL	Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in non-wetlands in the region specified.
FACU-	Same as FACU above except the negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).
FAC-	Same as FAC above except the negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands).

FIGURE B-1. DENSITY DISTRIBUTION CLASSES

Class	Description	Distribution
1	Rare individual, a single occurance	
2	A few sporatically occuring individuals	
3	A single patch or clump of a species	
4	Several sporadically occurring individuals	
5	A few patches or clumps of a species	
6	Several well spaced patches or clumps	
7	Continuous uniform occurrence of a species with a few gaps in the distribution	
8	Continuous occurrence of a species with a few gaps in the distribution	
9	Continuous dense occurrence of a species	

Source: Robinson et al. 1990

FIGURE B-2. SLOPE POSITIONS



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